GrandView
AT ANNAPOLIS TOWNE CENTRE AT PAROLE

Matt Karle

Construction Management

AE SENIOR THESIS PROJECT

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GrandView
AT ANNAPOLIS TOWNE CENTRE AT PAROLE

Presentation Outline

Building Overview
Schedule & Cost
Overall Goals
Solar PV Implementation (Electrical Breadth)
Window Glazing
Solar Constructability and Future
Recommendations
Questions

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Project Information

13 Stories
Ground: Retail
2-12: Residential

385,000 ft2
125 Total Units
Top 2 Floors – Penthouse Suites

- Building Overview
- Schedule & Cost
- Overall Goals
- Solar PV Implementation
- Glazing
- Solar Constructability and Future
- Recommendations
- Questions

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Client Information

Greenberg Gibbons Commercial
Sturbridge Homes
Gilbane
Martin Architectural Group

Large Joint Venture
1 of 2 Condo Projects

- Building Overview
- Schedule & Cost
- Overall Goals
- Solar PV Implementation
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GrandView
at Annapolis Towne Center
at Parole
GrandView
AT ANNAPOLIS TOWNE CENTRE AT PAROLE
Location & Layout
Demolished Strip Mall
Grandview at Annapolis Towne Centre
1915 Towne Centre Blvd
Annapolis, MD 21401
Building Overview
Schedule & Cost
Overall Goals
Solar PV
Implementation
Glazing
Solar Constructability
and Future
Recommendations
Questions
Main Office
Field Office
GrandView
Laydown
Parking
Traffic
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Building Systems
2-Way Flat Slab
Brick Façade
Curved Glass Curtain Walls
Separate Service Utilities for
Residential and Retail
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AT ANNAPOLIS TOWNE CENTRE AT PAROLE
Fiscal Projections
$68.5 Million
Projected : 24 Months Construction
Actual: March 07 – June 09
Building Overview
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Implementation
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Solar Constructability
and Future
Recommendations
Questions
GrandView at ATC Schedule Summary
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AT ANNAPOLIS TOWNE CENTRE AT PAROLE
Overall Project Statement
What effects can the sun have on reducing energy costs and environmental impacts while maintaining constructability and schedule length?
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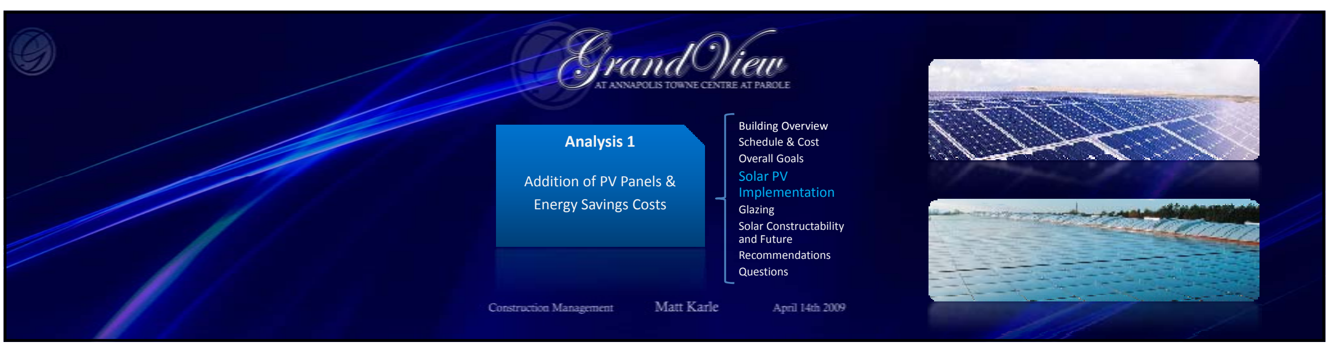
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AT ANNAPOLIS TOWNE CENTRE AT PAROLE
Analysis 1
Addition of PV Panels & Energy Savings Costs
Building Overview
Schedule & Cost
Overall Goals
Solar PV Implementation
Glazing
Solar Constructability and Future
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INVERTER SPECIFICATIONS: GT5.0	
Power Data	
Max AC Power Output	5000 W : 4500 W
AC OUTPUT (nominal)	240 V : 208 V
AC FREQUENCY (nominal)	60 Hz
Max Continuous Output Current	21-22 A
Max Output over Current Protection	30
Max Utility Backfeed Current	12:00 AM
Power Factor	>0.99
Output Characteristics	Current Source
Size	
Weight	58 lbs.
Dimensions	29" x 16 " x 6"

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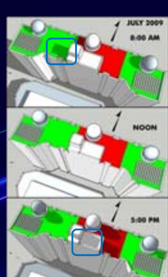
AT ANNAPOLIS TOWNE CENTRE AT PAROLE

Design Criteria

BP Solar sx3200 200 Watt PV Module
- 34 lbs
- 66" x 33"

Xantrex GT 5.0 Grid Tie Solar Inverters
- 5000 Watt / 240 V



Club Area
Available Area

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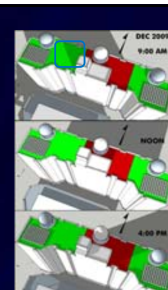
AT ANNAPOLIS TOWNE CENTRE AT PAROLE

Shadow Analysis

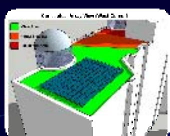
July and December
Uniform Layout
Not Visible From Tenant Area

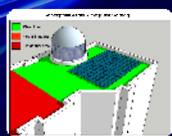
2 Arrays on **East** and **West** End of the Building



Club Area
Available Area

GrandView
AT ANNAPOLIS TOWNE CENTRE AT PAROLE





Initial Design

3025 Square Feet

200 panels (10 X10)

40 kW array

- Building Overview
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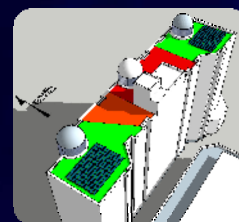

Southern Facing

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GIVEN — Basic Array Design and Layout

- Two (2) Separate Array locations at opposite ends of the roof
- Each Array consists of 100 panels arranged in rows of 10 (200 total panels)
- Panels are rated at 200W and measure 66" x 33" for a total area of 15.13 ft^2
- The Array is fixed facing directly south with the optimal 39.2 degree tilt for its location
- Xantrex GT5.0 Inverters have been chosen to convert to AC power

STEP 1 — Determining the Number of Panels in a Series

Using the open circuit voltage of 30.8V per panel and the U.S. NEC Rating of 600V, it is determined that 19.5 panels are allowable per series which converts to a round number of 20 panels per series.

Number of Panels in Series = (600V)/(30.8V/Panel) = 19.48 = 20 Panels

STEP 2 — Sizing the Inverters

In order to size the inverters, the number of panels in a series is multiplied by the max power of each panel.

Size of Inverter = (20 Panels)(200 W/Panel) = 4000 W = 4 kW

Based on this data the Xantrex GT 5.0 was chosen which is rated at 5000 W and has a 208 V AC output. The full specs for the GT 5.0 Inverter can be found in Appendix C

STEP 3 — Determining the Number of Inverters Required

Calculating the number of inverters required is as simple as dividing the total number of panels in the array by the number of panels in a series. The result yields a total of 10 inverters.

Number of Inverters = (200 Panels)(20 Panels/Series) = 10 Inverters

Electrical Breadth

Panels In Series
20

Inverter Size
4 kW → 5 kW

Number of Inverters
10

- Building Overview
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KNOWN — Electrical Impact and System Integration

- Integrate into powering the rooftop and all of the corridor lighting loads
- Electrical Rooms on the Roof and 12th floors have room to house the inverters
- Rooms are close to inverters and array system which requires minimal wiring
- Inverters are considered single phase loads and require 2 "spare locations" for the 2 phase wires
- Each of the two separate 20 Kw array systems will be fed into two separate panel boards

STEP 1 — Confirm Panel Boards have Sufficient Load Capacity

Using the open circuit voltage of 30.8V per panel and the U.S. NEC Rating of 600V, it is determined that 19.5 panels are allowable per series which converts to a round number of 20 panels per series.

Max Panel Loading = (175 A)(208V)$(3)^{1/2}$ = 63046.6 W = 63 kW

STEP 2 — Checking to Confirm the Total Inverter Load on the Panel Board

Since 10 Inverters will be placed on this panel board, it is necessary to determine whether or not the total load of the inverters is less than the panel board load capacity. In order to determine the number of inverters was multiplied by the load that each supplies.

Total Inverter Load = (10 Inverters)(4.0 kW) = 40 kW

From the above calculations it is determined that 40 kW < 49.8 kW therefore the Panel Board can support the load supplied by the inverters.

The 49.8 kW comes from the total capacity minus the existing load (63 kW – 13.2 kW)

STEP 3 — Determining Load Each Inverter has on the Panel Board

For a single phase, it is determined that the load of each inverter needs to be divided by 2 in order to get the loading of each on the panel board.

Load Per Inverter on P.B. = (4.0 Kw)/(2) = 2.0 kW

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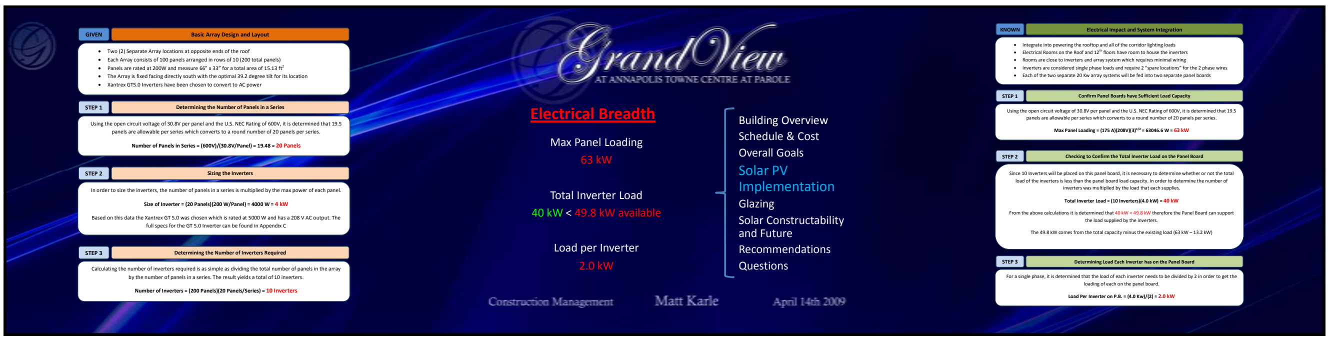
GIVEN
Basic Array Design and Layout
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GrandView
AT ANNAPOLIS TOWNE CENTRE AT PAROLE
Electrical Breadth
Max Panel Loading
63 kW
Total Inverter Load
40 kW < 49.8 kW available
Load per Inverter
2.0 kW
Building Overview
Schedule & Cost
Overall Goals
Solar PV
Implementation
Glazing
Solar Constructability and Future
Recommendations
Questions
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GrandView
AT ANNAPOLIS TOWNE CENTRE AT PAROLE
Electrical Breadth
Circuit Breaker Size
25A
Open Panel Board on Roof that can accommodate all Inverters
Building Overview
Schedule & Cost
Overall Goals
Solar PV
Implementation
Glazing
Solar Constructability and Future
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AT ANNAPOLIS TOWNE CENTRE AT PAROLE

Structural and Schedule Impact

5-Man Crew
Install 10 Panels / Hour = 20 Hours

Tubular Steel Inc

Quoted Support Structure

+$4700.00

Total Panel and Support Load = 3 lb/sf

PV Watts

40 kW array
Convert to AC Power

49,111 kWh per Year

Power Data (kWh/m2day) Angled Array- Annapolis, MD												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Power	3.49	4.41	4.79	5.11	5.26	5.67	5.59	5.27	4.95	4.91	3.59	2.86

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AT ANNAPOLIS TOWNE CENTRE AT PAROLE

INITIAL INVESTMENT			
Item	Quantity	Cost / Unit	Total Cost
PV Panels	40000 W	$8.0/W	$320,000.00
Inverters	10	$3,060	$30,600.00
Savings	Federal: $10,000		-$10,000.00
	State: $3,000		-$3,000.00
Total Cost			$337,600.00

Initial Investment

Federal Incentive: $10,000
Maryland Incentive: $3,000

Possible: 30% Tax Cut
Carbon Tax

SAVINGS PER YEAR			
Month	(AC) kWh/month	Savings($)	Savings(lbs of CO_2)
JAN	3390.00	$469.18	5424
FEB	3862.00	$534.50	6179
MAR	4469.00	$618.51	7150
APR	4520.00	$625.57	7232
MAY	4630.00	$640.79	7408
JUN	4648.00	$643.28	7437
JUL	4714.00	$652.42	7542
AUG	4437.00	$614.08	7099
SEP	4096.00	$566.89	6554
OCT	4400.00	$608.96	7040
NOV	3242.00	$448.69	5187
DEC	2704.00	$374.23	4326
TOTAL SAVINGS		$6,797.10	78,579

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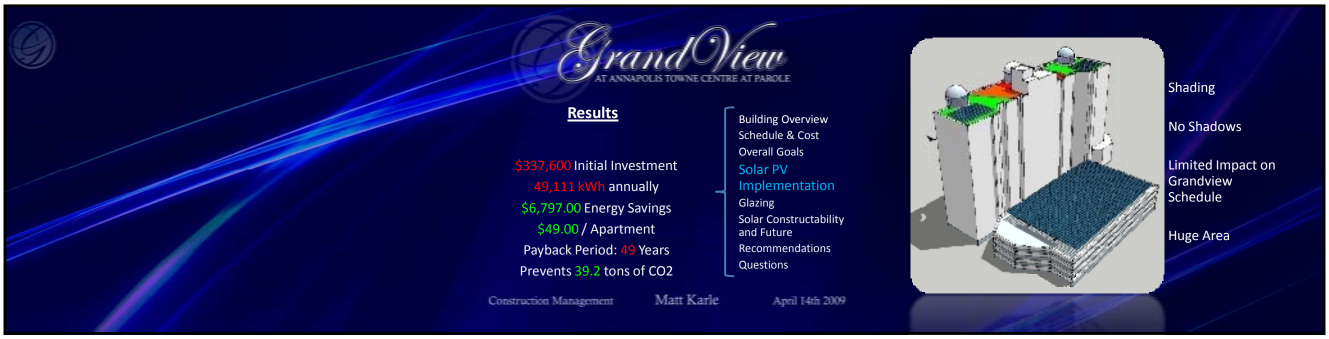
GrandView
AT ANNAPOLIS TOWNE CENTRE AT PAROLE
Results
$337,600 Initial Investment
49,111 kWh annually
$6,797.00 Energy Savings
$49.00 / Apartment
Payback Period: 49 Years
Prevents 39.2 tons of CO2
Building Overview
Schedule & Cost
Overall Goals
Solar PV Implementation
Glazing
Solar Constructability and Future
Recommendations
Questions
Shading
No Shadows
Limited Impact on Grandview Schedule
Huge Area
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GrandView
AT ANNAPOLIS TOWNE CENTRE AT PAROLE
Analysis 2
Thermal Window and Glazing Substitution
Building Overview
Schedule & Cost
Overall Goals
Solar PV Implementation
Glazing
Solar Constructability and Future
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Questions
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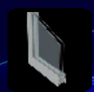
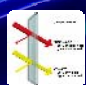
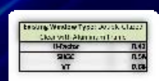
Grand View
AT ANNAPOLIS TOWNE CENTRE AT PAROLE

Existing Window Type



- Double Glazed
- Clear
- Aluminum Frame





Design Methodology

Conduction:
Better Frame
Double & Triple Pane

Solar Gain:
Low Solar Gain Glazing
Low SHGC

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Schedule & Cost
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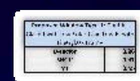
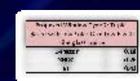
Solar Constructability and Future
Recommendations
Questions

Proposed Window Types

- Double & Triple Pane
- Low Solar Gain Glazing
- Fiberglass Frame





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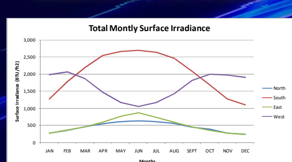
Grand View
AT ANNAPOLIS TOWNE CENTRE AT PAROLE



Goals

Run a Fenestration Heat Analysis
Determine Energy Costs
(Cooling Load Only)

Heating Variables: Humans, Lights, Oven, Computer…

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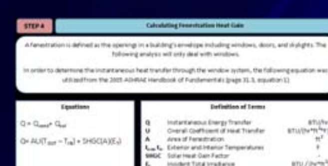

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AT ANNAPOLIS TOWNE CENTRE AT PAROLE

Monthly Cooling Load Values

		Total Daily (Million Btu's)			Total Monthy (Million Btu's)			Total Savings (Million Btu's)	
Time	Days	Current	Design 1	Design 2	Current	Design 1	Design 2	Design 1	Design 2
JAN	31	14.6	6.0	4.1	454.1	185.0	128.1	269.1	326.1
FEB	29	19.3	7.9	5.5	560.9	230.0	159.3	330.9	401.7
MAR	31	24.2	10.2	7.1	748.8	316.3	219.0	432.5	529.8
APR	30	29.4	12.8	8.9	882.6	385.2	266.7	497.4	616.0
MAY	31	31.8	14.1	9.8	987.0	437.3	302.8	549.7	684.3
JUN	30	34.7	15.8	10.9	1040.3	472.8	327.4	567.5	713.0
JUL	31	36.1	16.7	11.6	1119.1	518.2	358.8	600.9	760.3
AUG	31	30.4	13.6	9.4	943.8	420.8	291.3	522.9	652.4
SEPT	30	26.8	12.0	8.3	805.1	359.1	248.6	446.0	556.5
OCT	31	21.1	9.1	6.3	654.4	282.3	195.4	372.0	458.9
NOV	30	15.9	6.7	4.7	477.4	201.7	139.7	275.6	337.7
DEC	31	13.0	5.3	3.7	402.7	163.5	113.2	[illegible]	[illegible]
			Yearly Totals		9076.2	3972.4	2750.1	5103.8	6326.1
				Percent Savings			Percent Savings	56%	70%

Findings

Design 1: Saved 56% Cooling Load
Design 2: Saved 70% Cooling Load

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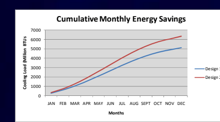

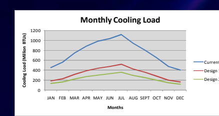

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			Yearly Totals		9076.2	3972.4	2750.1	5103.8	6326.1
				Percent Savings			Percent Savings	56%	70%

Life Cycle and Energy

Annually:

Design 1: Saved $61,783 Electricity
1200 TONS of CO2

Design 2: Saved $76,579 Electricity
1480 TONS of CO2

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Cost Comparison

Design	Difference in Cost per SF	Area (SF)	Initial Cost Difference	Magic-Pak SEER	Annual Cooling Cost	Annual Cooling Savings	Percent Savings
Current	$ -	38,376	$ -	11.4	$ 109,870	$ -	0%
Design 1	$ 2.41	38,376	$ 92,486.16	11.4	$ 48,087	$ 61,783	56%
Design 2	$ 5.22	38,376	$ 200,322.72	11.4	$ 33,291	$ 76,579	70%

Yearly CO2 Savings Impact

Design	Window Type	Million BTUs	kWh	Lbs CO2 / kwh	Tons of CO2
Design 1	Double Pane Low-E	5104	1495787	1.6	1196.6
Design 2	Triple Pane Low-E	6326	1854001	1.6	1483.2

FUN FACT:

A 1200 ton CO2 savings is equivalent of a 400 Passenger Boeing 747 making a round trip from DC TO LA. Therefore, over a period of ten years, installing Design 1 would be equivalent of canceling 10 round trip flights of a 747 across the country.

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GrandView
AT ANNAPOLIS TOWNE CENTRE AT PAROLE

Schedule and Constructability

Only Schedule Impact Lead Time

Constructability:
Double Pane: Same Weight and Design

Triple Pane: Heavier Different Design
**Require Structure Modifications

- Building Overview
- Schedule & Cost
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- Questions

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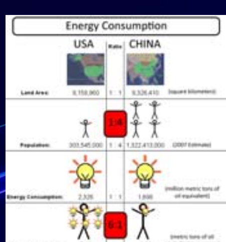

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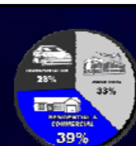
Energy Consumption

How does America compare?

China

- Building Overview
- Schedule & Cost
- Overall Goals
- Solar PV Implementation
- Glazing
- Solar Constructability and Future
- Recommendations
- Questions



Residential and Commercial Make Up Bulk of Energy Usage:
Tells us that we need to build smarter!!

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Would you be inclined to install PV panels on the current project you are working on or your home?
Yes 15%
No 85%
A staggering 85% of the 40 respondents polled said that they would not currently install a PV array on their current building or their home. The fact that such a high percentage declined installation alludes to the fact that something is still pushing consumers away from this energy saving technology.
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Solar Growth and Constructability
40 Respondents in the Construction Industry, mainly Contractors in the D.C. area, were asked their views on Solar Energy.
Building Overview
Schedule & Cost
Overall Goals
Solar PV Implementation
Glazing
Solar Constructability and Future
Recommendations
Questions
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What is the top constructability issue concerning the implementation of a solar array?
Building Implementation 7%
Installation 5%
Aesthetics 17%
Cost 49%
Usable area 22%
Cost was the number one answer that deterred people from installing a system. This is likely due to a low amount of government incentives available as well as the high cost of the panels and installation. Available area and correct orientation is also a major concern. If a building is not oriented South or if it has limited roof area, it makes solar arrays largely unappealing. The bottom three concerns were aesthetics , connecting the system to the building, and overall installation process.


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What would make you more willing to install a system?
8%
Better Aesthetics 7%
Lower Initial Cost 37%
Higher Government Incentives 30%
Better Efficiency 15%
TOP 3:
Lower Initial Cost
Higher Incentives
Better Efficiency
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Conclusions and Recommendations
PV PANELS IMPLEMENTATION
While photovoltaic panels seem to be the way of the future, it is my recommendation that at this point in time GrandView does not add PV's to the roof.
The low energy gain as compared to each apartment does not seem financially smart when a 49 year payback period exists.
It would be smart to wait 5 years to see what type of new and cheaper PV technology comes out that would allow a much smaller payback period.
THERMAL WINDOW SUBSTITUTION
From an economic, financial, and comfort point of view, I would highly recommend upgrading to a low solar gain glazing on the windows.
However, I would keep the windows double pane as they already are and keep the aluminum frames. These only add to the cost of the units and do not provide substantial enough energy savings in the long run as compared to radiation.
SOLAR PANELS AND THE ECONOMY
I recommend that the government provide better funding for renewable energy research as well as provide better federal and state tax cuts and grants for installing energy saving technology.
It is my hope that we one day surpass China.
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Thank You
I wld b plsd to nswr qustns t ths tm
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