2175 K Street NW
Washington DC, 20037

TIMOTHY CONROY

MAE

CONSTRUCTION MANAGEMENT

SPRING 2010

JIM FAUST

Presentation Outline

Project Overview

- 2175 K Street NW, Washington DC 20037
- 8-story existing concrete building (Built in 1981)
- 3-new structural steel levels
- 108,000 square feet
- 37,500 square feet new construction
- Contract Value: $15.5 million GMP
- Delivery Method: CM Agency with GC
- Schedule Duration: Feb 07 to Mar 10

Project Team

- Owner: Minstall Stewart Properties
- Architect: FOX Architects
- Structural Engineer: Rathgeber/Goss Associates
- MEP Engineer: META Engineers
- General Contractor: James G. Davis Construction

Enlarged Vicinity Map

http://maps.google.com/

Rendering Provided by FOX Architects

Presentation Outline

Overall Goal

§ The theme for the selected analysis topics is reducing building electricity consumption while minimizing upfront costs wherever possible and providing the owner with a building with a higher overall value.

http://www.geindustrial.com/

Green Building Research

In the United States alone, buildings account for:

- 72% of electricity consumption,
- 39% of energy use,
- 38% of all carbon dioxide (CO_2) emissions,
- 40% of raw materials use,
- 30% of waste output (136 million tons annually), and
- 14% of potable water consumption.

http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1718

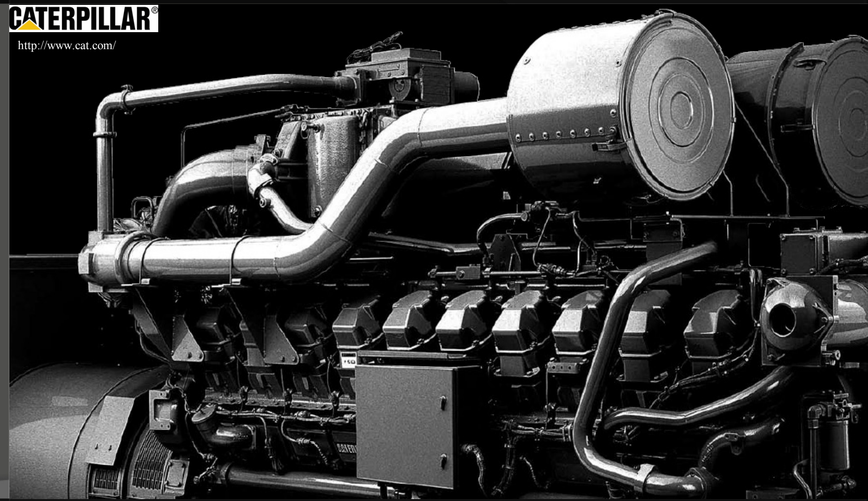
http://www.usgbc.org

Presentation Outline

- § Project Overview
- § Overall Goal
- § *Backup Generator Analysis*
  - • *Area of Potential Improvement*
  - • Proposed Solution
  - • Benefits and Drawbacks
  - • Resulting Energy Savings
  - • Sound Attenuation
  - • Schedule and Constructability
  - • Conclusion
- § Green Roof Analysis
- § Curtain Wall Redesign Analysis
- § Smart Power Strip Analysis
- § Summary of Findings
- § Acknowledgements

Backup Generator Analysis

There are substantial costs associated with backup generators yet they are only used in an emergency situation or to test its operation



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Construction Management

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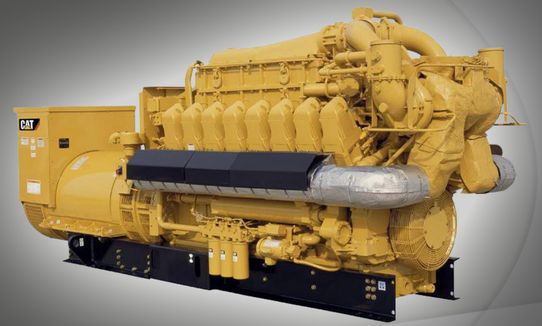
Backup Generator Analysis

Is it possible to use the building's existing backup generator to offset its electrical usage?

This analysis looks into the feasibility of the above statement



CAT
http://www.cat.com/

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2175 K Street NW, Washington DC 20037

Construction Management

BACKUP GENERATOR ANALYSIS

BENEFITS

OFFSET BUILDING'S ELECTRICAL DEMAND

DRAWBACKS

DANGEROUS BYPRODUCTS OF COMBUSTION
SOUND GENERATION AND HEARING LOSS

BACKUP GENERATOR ANALYSIS

BASE CASE
(CUMMINS DIESEL GENERATOR)

- *CAPACITY: 350 KW*
- *FUEL CONSUMPTION: 23.15 GAL/HR*
- *YEARLY SAVINGS: $96,283*
- *YEARLY FUEL COST: $143,782*
- *NET SAVINGS: -$47,499*

- *BREAK EVEN: 15.50 GAL/HR*

Energy Calculations

Savings Subtotal				
Daily	$92.58	$185.16	$277.74	$370.32
Weekly	$462.90	$925.80	$1,388.70	$1,851.60
Monthly	$1,851.60	$3,703.20	$5,554.80	$7,406.40
Yearly	$24,070.80	$48,141.60	$72,212.40	$96,283.20
Fuel Consumption				
			Gallons	
Daily	53.36	92.56	136.96	185.20
Weekly	266.80	462.80	684.80	926.00
Monthly	1,067.20	1,851.20	2,739.20	3,704.00
Yearly	13,873.60	24,065.60	35,609.60	48,152.00
Fuel Costs				
Daily	$159.33	$276.38	$408.96	$553.01
Weekly	$796.66	$1,381.92	$2,044.81	$2,765.04
Monthly	$3,186.66	$5,527.68	$8,179.25	$11,060.14
Yearly	$41,426.57	$71,859.88	$106,330.27	$143,781.87
Net Savings				
Daily	✖ ($66.75)	✖ ($91.22)	✖ ($131.22)	✖ ($182.69)
Weekly	✖ ($333.76)	✖ ($456.12)	✖ ($656.11)	✖ ($913.44)
Monthly	✖ ($1,335.06)	✖ ($1,824.48)	✖ ($2,624.45)	✖ ($3,653.74)
Yearly	✖ ($17,355.77)	✖ ($23,718.28)	✖ ($34,117.87)	✖ ($47,498.67)

**Current fuel tank is rated for 4 hours of continuous operation.*

BACKUP GENERATOR ANALYSIS

ALTERNATE CASE
(CAT NATURAL GAS GENERATOR)

- *CAPACITY: 1040 kW*
- *FUEL CONSUMPTION: 7899 FT^3/HR*
- *YEARLY SAVINGS: $333,782*
- *YEARLY FUEL COST: $198,473*
- *NET SAVINGS: $135,308*

- *BREAK EVEN: N/A*

Energy Calculations

Savings Subtotal				
Daily	$320.94	$641.89	$962.83	$1,283.78
Weekly	$1,604.72	$3,209.44	$4,814.16	$6,418.88
Monthly	$6,418.88	$12,837.76	$19,256.64	$25,675.52
Yearly	$83,445.44	$166,890.88	$250,336.32	$333,781.76
Fuel Consumption		Thousand Cubic Feet		
Daily	23.38	36.65	49.29	63.19
Weekly	116.91	183.26	246.45	315.96
Monthly	467.62	733.03	985.80	1,263.84
Yearly	6,079.07	9,529.35	12,815.34	16,429.92
Fuel Costs				
Daily	$282.44	$442.75	$595.42	$763.36
Weekly	$1,412.21	$2,213.74	$2,977.10	$3,816.80
Monthly	$5,648.86	$8,854.97	$11,908.41	$15,267.19
Yearly	$73,435.17	$115,114.59	$154,809.28	$198,473.43
Net Savings				
Daily	✓ $38.50	✓ $199.14	✓ $367.41	✓ $520.42
Weekly	✓ $192.51	✓ $995.70	✓ $1,837.06	✓ $2,602.08
Monthly	✓ $770.02	✓ $3,982.79	✓ $7,348.23	✓ $10,408.33
Yearly	✓ $10,010.27	✓ $51,776.29	✓ $95,527.04	✓ $135,308.33

**Based Upon Cat Natural Gas Generator Model G3412 1040kW*

BASE CASE
(CUMMINS DIESEL GENERATOR)

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BACKUP GENERATOR ANALYSIS

BASE CONSTRUCTION

CONCRETE AND CMU WALL
2" THK HOLLOW METAL DOOR

Transmission Loss						
	Frequency (Hz.)					
Material	125	250	500	1000	2000	4000
Concrete	38	43	52	59	67	72
CMU	34	40	44	49	59	64
Door	23	28	36	41	39	44

Sound Transmission						
Material	Tau					
Concrete	1.58E-04	5.01E-05	6.31E-06	1.26E-06	2.00E-07	6.31E-08
CMU	3.98E-04	1.00E-04	3.98E-05	1.26E-05	1.26E-06	3.98E-07
Door	5.01E-03	1.58E-03	2.51E-04	7.94E-05	1.26E-04	3.98E-05
Composite TL	29.5	34.6	41.9	47.0	46.4	51.4
Generator	100.3	104.8	109.9	113.1	111.7	109.7
Resulting Sound Level	70.8	70.2	68.0	66.1	65.3	58.3

Resulting Sound Level	70.8	70.2	68.0	66.1	65.3	58.3

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Backup Generator Analysis

Alternate Construction

Concrete and CMU Wall
2" Thk Hollow Metal Door

2" x 4" Staggered Wood Studs
16" o.c.
5/8" Gypsum Board Both Sides

Goal Transmission Loss

	Frequency (Hz.)					
Location Type	125	250	500	1000	2000	4000
Office Activities	50	50	50	50	50	50
Classroom	66	72	77	74	68	60
Normal Conversation	57	62	63	57	48	40

Transmission Loss

	Frequency (Hz.)					
Material	125	250	500	1000	2000	4000
Construction No. 7	17	31	33	40	38	36
Construction No. 8	15	30	34	44	46	41
Construction No. 9	23	28	29	46	54	44

Sound Transmission

Material	Tau					
Construction No. 7	2.00E-02	7.94E-04	5.01E-04	1.00E-04	1.58E-04	2.51E-04
Construction No. 8	3.16E-02	1.00E-03	3.98E-04	3.98E-05	2.51E-05	7.94E-05
Construction No. 9	5.01E-03	1.58E-03	1.26E-03	2.51E-05	3.98E-06	3.98E-05

Composite TL

Construction No. 7	46.5	65.6	74.9	87.0	84.4	87.4
Construction No. 8	44.5	64.6	75.9	91.0	92.4	92.4
Construction No. 9	52.5	62.6	70.9	93.0	100.4	95.4

Resulting Sound Level

Construction No. 9	47.8	42.2	39.0	20.1	11.3	14.3

						22.3
						17.3
Construction No. 9	47.8	42.2	39.0	20.1	11.3	14.3

Base Construction

Concrete and CMU Wall
2" Thk Hollow Metal Door

Transmission Loss

	Frequency (Hz.)					
Material	125	250	500	1000	2000	4000
Concrete	38	43	52	59	67	72
CMU	34	40	44	49	59	64
Door	23	28	36	41	39	44

Sound Transmission

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CMU	3.98E-04	1.00E-04	3.98E-05	1.26E-05	1.26E-06	3.98E-07
Door	5.01E-03	1.58E-03	2.51E-04	7.94E-05	1.26E-04	3.98E-05

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BACKUP GENERATOR ANALYSIS

SCHEDULE IMPACT

- *CONSTRUCTION TIME: 1-2 DAYS*
- *GAS LINE INSTALLATION: 15 TO 20 DAYS*
- *NET IMPACT ON OVERALL SCHEDULE: 0 DAYS*

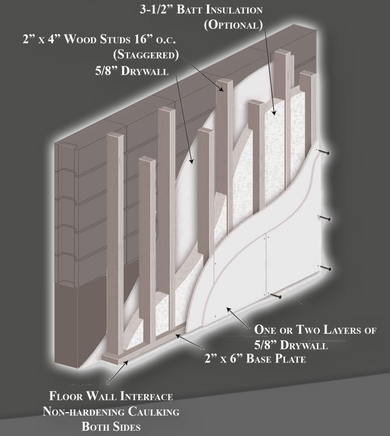
CONSTRUCTABILITY IMPACT

- *ALL GENERATORS STUDIED FIT WITHIN SPACE CONSTRAINTS*
- *NO ADDITIONAL DUCTWORK NEEDED*

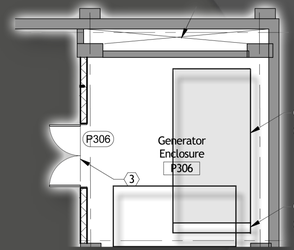
PAYBACK PERIOD

GENERATOR TYPE	CAPACITY (KW)	ANNUAL ENERGY SAVINGS	COST	ADDITIONAL COST	PAYBACK PERIOD
DIESEL	300	($47,499)	$58,800	--	N/A
NATURAL GAS	350	($35)	$137,200	$40,076	N/A
NATURAL GAS	450	$6,054	$176,400	$40,076	35.76
NATURAL GAS	1040	$135,308	$507,680	$40,076	4.05

Proposed Wall Construction



Generator Room Layout



BACKUP GENERATOR ANALYSIS

CONCLUSIONS

- *NATURAL GAS GENERATORS ARE BETTER SUITED*
- *EFFICIENCY CAN BE GAINED WITH LARGER CAPACITY GENERATORS*
- *PRE-PLANNING IS A MUST*
  - *GENERATOR SELECTION*
  - *ENCLOSURE CONSTRUCTION*
  - *ADEQUATE FUEL SUPPLY*
- *FURTHER RESEARCH NEEDED INTO MORE EFFERENT GENERATORS*

Summary							
	Frequency (Hz.)						Per Activity
	125	250	500	1000	2000	4000	
Construction No. 7							
Office Activities	✗	✓	✓	✓	✓	✓	✗
Classroom	✓	✓	✓	✓	✓	✓	✓
Normal Conversation	✓	✓	✓	✓	✓	✓	✓
Construction No. 8							
Office Activities	✗	✓	✓	✓	✓	✓	✗
Classroom	✓	✓	✓	✓	✓	✓	✓
Normal Conversation	✓	✓	✓	✓	✓	✓	✓
Construction No. 9							
Office Activities	✓	✓	✓	✓	✓	✓	✓
Classroom	✓	✓	✓	✓	✓	✓	✓
Normal Conversation	✓	✓	✓	✓	✓	✓	✓

Construction Description	
Construction No. 7	2 by 4 wood studs 16 in oc with 1/2-in gypsum board both sides
Construction No. 8	Construction No. 7 with 2-in glass-fiber insulation in cavity
Construction No. 9	2 by 4 staggered wood studs 16 in oc with 5/8-in gypsum board both sides

GREEN ROOF ANALYSIS

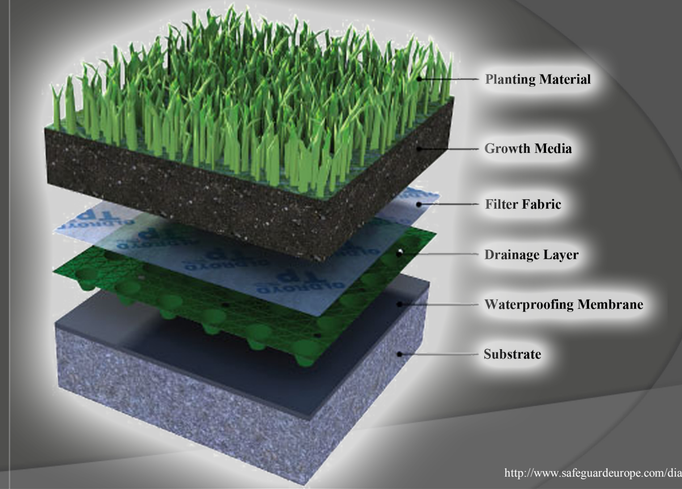
BUILDING ROOF ACCOUNTS FOR 25% OF BUILDING ENVELOPE

NUMEROUS ENVIRONMENTAL BENEFITS

OCCUPANT BENEFITS

GREEN ROOF ANALYSIS

UTILIZE THE BENEFICIAL PROPERTIES OF A GREEN ROOF TO ADD VALUE TO THE PROJECT WHILE MINIMIZING THE ADDED COST



http://www.safeguardeurope.com/diagrams/flat-green-roof-build-up.jpg

GREEN ROOF ANALYSIS

BENEFITS

INCREASED DURABILITY OF ROOF ASSEMBLY
ALLOWS TIME FOR VEGETATION TO DEVELOP BEFORE INSTALLATION
REDUCED HEAT ISLAND EFFECT
REDUCTION OF SMOG
DECREASED STORMWATER RUNOFF
ADDED HABITAT FOR BIRDS, PLANTS, AND INSECTS

DRAWBACKS

MODULAR SYSTEM HAS A NEGLIGIBLE EFFECT ON THERMAL RESISTANCE
INCREASED STRUCTURAL LOADS
ADDED MAINTENANCE

GREEN ROOF ANALYSIS

EXISTING SYSTEM

GRAVEL BALLAST
FULLY ADHERED SINGLE PLY EPDM
RIGID INSULATION TAPERED TOWARD THE ROOF DRAINS
3" DEEP RIB 20 GAUGE METAL ROOF DECK

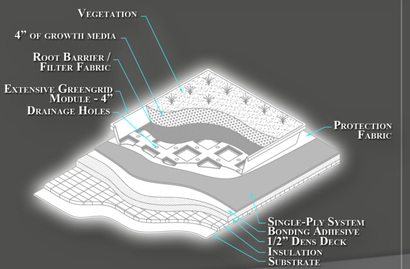
Image Provided by DAVIS Construction

GREEN ROOF ANALYSIS

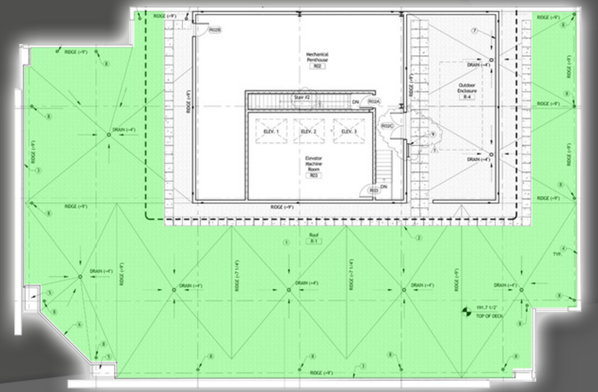
GREEN ROOF (GREENGRID® SYSTEM)

- *EXTENSIVE GREENGRID® ROOF SYSTEM*
  - *VEGETATION*
  - *4" OF GROWTH MEDIA*
  - *ROOT BARRIER/FILTER FABRIC*
  - *GREEN GRID MODULE*
  - *UNIT WEIGHT 20 PSF*
- *INSTALLATION RATE: 3,000 TO 5,000 SQFT PER DAY (8,000 SQFT MAX)*
- *NO INSTALLATION BETWEEN OCTOBER AND APRIL*

EXTENSIVE
GREENGRID(R) GREEN ROOF SYSTEM
TYPICAL ASSEMBLY FOR A
SINGLE-PLY SYSTEM (EPDM, TPO, PVC, MOD BIT)



GREEN ROOF AREA



GREEN ROOF ANALYSIS

STRUCTURAL LOAD ANALYSIS

LIMITING FACTOR: BEAMS
CONCRETE ON METAL DECK: 3C20 - 7" (T=4") NW

LOAD CARRYING CAPACITY:
BEAMS: REVERSE LOOKUP IN STEEL MANUAL
DECK: VOLCRAFT DECK CATALOGUE

SEVEN LOAD COMBINATIONS CHECKED

RESULTING NET ADDITIONAL LOAD: 69.60 PSF

Structural Calculations (Green Roof)

Function	No.	Size	Weight lb/lf	Length ft	Spacing ft	fM_p ft-K	Load k/ft	Load lb/ft	Controlling Load	Beam Wt lb/ft	Net Load lb/ft	Net Load lb/ft^2	Deck Wt 7" (t=4") NW Type	Deck Wt 7" (t=4") NW lb/ft^2	Deck Wt 7" (t=4") NW Capacity	Net Allowable Load lb/ft^2
Beam	1	W18x35	35	36.33	7.75	249	1.51	1508.96	1077.83	35	1042.83	134.56	3C20	53.00	98.00	81.56
	2	W18X35	35	35.08	8.50	249	1.62	1618.41	1156.00	35	1121.00	131.88	3C20	53.00	98.00	78.88
	3	W18x35	35	35.08	9.00	249	1.62	1618.41	1156.00	35	1121.00	124.56	3C20	53.00	98.00	71.56
	4	W18x35	35	35.08	6.75	249	1.62	1618.41	1156.00	35	1121.00	166.07	3C20	53.00	98.00	113.07
	5	W21X44	44	39.51	8.50	358	1.83	1834.64	1310.45	44	1266.45	148.99	3C20	53.00	98.00	95.99
	6	W21X44	44	39.51	7.88	358	1.83	1834.64	1310.45	44	1266.45	160.82	3C20	53.00	98.00	107.82
	7	W18x40	40	37.58	9.13	294	1.67	1665.12	1189.37	40	1149.37	125.96	3C20	53.00	98.00	72.96
	8	W18x40	40	37.58	9.38	294	1.67	1665.12	1189.37	40	1149.37	122.60	3C20	53.00	98.00	69.60
	9	W21x44	44	36.58	6.00	358	2.14	2139.96	1528.55	44	1484.55	247.42	3C20	53.00	98.00	194.42
	10	W21X44	44	37.58	4.32	358	2.03	2027.60	1448.29	44	1404.29	325.16	3C20	53.00	98.00	272.16
	*11**	*W18x76*	*76*	*35.08*	*9.00*	*611*	*3.97*	*3971.27*	*2836.62*	*76*	*2760.62*	*306.75*	3C20	53.00	98.00	253.75
	*12**	*W18x60*	*60*	*36.33*	*7.75*	*461*	*2.79*	*2793.70*	*1995.50*	*60*	*1935.50*	*249.74*	3C20	53.00	98.00	196.74
	13	W21x50	50	39.51	6.84	413	2.12	2116.49	1511.78	50	1461.78	213.67	3C20	53.00	98.00	160.67
	14	W12x19	19	24.50	6.63	92.6	1.23	1234.15	878.46	19	859.46	129.73	3C20	53.00	98.00	76.73
	15	W18x40	40	24.50	3.83	294	3.92	3918.37	2798.83	40	2758.83	719.76	3C20	53.00	98.00	666.76
	16	W24x104	104	39.51	9.50	1080	5.53	5534.65	3953.32	104	3849.32	405.19	3C20	53.00	98.00	352.19
	17	W16x26	26	23.25	5.79	166	2.46	2456.70	1754.79	26	1728.79	298.58	3C20	53.00	98.00	245.58
	18	W12x14	14	6.50	5.75	65.2	12.35	12345.56	8818.26	14	8804.26	1531.18	3C20	53.00	98.00	1478.18
	19	W14x22	22	11.50	17.50	125	7.56	7561.44	5401.03	22	5379.03	307.37	3C20	53.00	98.00	254.37
	20	W21x44	44	23.25	5.25	358	5.30	5298.18	3784.42	44	3740.42	712.46	3C20	53.00	98.00	659.46

MINIMUM NET LOAD (PSF)	98.00	69.60
CONTROLLING NET ALOWABLE LOAD (PSF)		69.60

GREEN ROOF ANALYSIS

DEFLECTION ANALYSIS

GREEN ROOF LOAD
MAX DEFLECTION: 0.2092"
(0% OF BEAMS FAIL)

FULLY LOADED
MAX DEFLECTION:0.2549"
(20% OF BEAMS FAIL)

Deflection Summary (q=20.0 psf)

	Member Properties									Deflection	Check L/180
	Size	Height	Base	T Web	T Flange	Length	Max Load	I	E		
W	18x35	17.75	6.00	0.3125	0.4375	36.33	1643.58	7.92	2.90E+07	0.162	0.2019 ✓
W	18X35	17.75	6.00	0.3125	0.4375	35.08	1776.50	7.92	2.90E+07	0.153	0.1949 ✓
W	18x35	17.75	6.00	0.3125	0.4375	35.08	1813.00	7.92	2.90E+07	0.156	0.1949 ✓
W	18x35	17.75	6.00	0.3125	0.4375	35.08	1648.75	7.92	2.90E+07	0.142	0.1949 ✓
W	21X44	20.63	6.50	0.3750	0.4375	39.51	1930.95	10.10	2.90E+07	0.209	0.2195 ✓
W	21X44	20.63	6.50	0.3750	0.4375	39.51	1885.33	10.10	2.90E+07	0.204	0.2195 ✓
W	18x40	17.88	6.00	0.3125	0.5000	37.58	1855.50	9.04	2.90E+07	0.184	0.2088 ✓
W	18x40	17.88	6.00	0.3125	0.5000	37.58	1873.75	9.04	2.90E+07	0.186	0.2088 ✓
W	21x44	20.63	6.50	0.3750	0.4375	36.58	1966.55	10.10	2.90E+07	0.157	0.2032 ✓
W	21X44	20.63	6.50	0.3750	0.4375	37.58	1763.55	10.10	2.90E+07	0.156	0.2088 ✓
W	18x76	18.25	11.00	0.4375	0.6875	35.08	3493.59	76.37	2.90E+07	0.031	0.1949 ✓
W	18x60	*18.25*	*7.50*	*0.4375*	*0.6875*	36.33	2561.25	24.29	2.90E+07	0.083	0.2019 ✓
W	21x50	*20.88*	*6.50*	*0.3750*	*0.5625*	39.51	2011.20	12.96	2.90E+07	0.170	0.2195 ✓
W	12x19	12.13	4.00	0.2500	0.3750	24.50	1362.09	2.01	2.90E+07	0.109	0.1361 ✓
W	18x40	17.88	6.00	0.3125	0.5000	24.50	3078.64	9.04	2.90E+07	0.055	0.1361 ✓
W	4x104	24.00	12.75	0.5000	0.7500	39.51	4646.82	129.78	2.90E+07	0.039	0.2195 ✓
W	16x26	15.75	5.50	0.2500	0.3750	23.25	2177.46	5.22	2.90E+07	0.055	0.1292 ✓
W	12x14	11.88	4.00	0.1875	0.2500	6.50	9238.01	1.34	2.90E+07	0.006	0.0361 ✓
W	14x22	13.75	5.00	0.2500	0.3125	11.50	6678.53	3.27	2.90E+07	0.016	0.0639 ✓
W	21x44	20.63	6.50	0.3750	0.4375	23.25	4167.67	10.10	2.90E+07	0.054	0.1292 ✓

MAX DEFLECTION 0.2092 IN.

Deflection Summary (q=69.6 psf)

	Member Properties									Deflection	Check L/180
	Size	Height	Base	T Web	T Flange	Length	Max Load	I	E		
W	18x35	17.75	6.00	0.3125	0.4375	36.33	2027.98	7.92	2.90E+07	0.2004	0.2019 ✓
W	18X35	17.75	6.00	0.3125	0.4375	35.08	2198.10	7.92	2.90E+07	0.1888	0.1949 ✓
W	18x35	17.75	6.00	0.3125	0.4375	35.08	2259.40	7.92	2.90E+07	0.1941	0.1949 ✓
W	18x35	17.75	6.00	0.3125	0.4375	35.08	1983.55	7.92	2.90E+07	0.1704	0.1949 ✓
W	21X44	20.63	6.50	0.3750	0.4375	39.51	2352.55	10.10	2.90E+07	0.2549	0.2195 ✗
W	21X44	20.63	6.50	0.3750	0.4375	39.51	2275.93	10.10	2.90E+07	0.2466	0.2195 ✗
W	18x40	17.88	6.00	0.3125	0.5000	37.58	2308.10	9.04	2.90E+07	0.2286	0.2088 ✗
W	18x40	17.88	6.00	0.3125	0.5000	37.58	2338.75	9.04	2.90E+07	0.2317	0.2088 ✗
W	21x44	20.63	6.50	0.3750	0.4375	36.58	2264.15	10.10	2.90E+07	0.1803	0.2032 ✓
W	21X44	20.63	6.50	0.3750	0.4375	37.58	1977.76	10.10	2.90E+07	0.1754	0.2088 ✓
W	18x76	18.25	11.00	0.4375	0.6875	35.08	3939.96	76.37	2.90E+07	0.0351	0.1949 ✓
W	18x60	*18.25*	*7.50*	*0.4375*	*0.6875*	36.33	2945.65	24.29	2.90E+07	0.0949	0.2019 ✓
W	21x50	*20.88*	*6.50*	*0.3750*	*0.5625*	39.51	2350.53	12.96	2.90E+07	0.1985	0.2195 ✓
W	12x19	12.13	4.00	0.2500	0.3750	24.50	1690.69	2.01	2.90E+07	0.1357	0.1361 ✓
W	18x40	17.88	6.00	0.3125	0.5000	24.50	3268.76	9.04	2.90E+07	0.0585	0.1361 ✓
W	24x104	24.00	12.75	0.5000	0.7500	39.51	5118.02	129.78	2.90E+07	0.0432	0.2195 ✓
W	16x26	15.75	5.50	0.2500	0.3750	23.25	2464.64	5.22	2.90E+07	0.0620	0.1292 ✓
W	12x14	11.88	4.00	0.1875	0.2500	6.50	9523.21	1.34	2.90E+07	0.0057	0.0361 ✓
W	14x22	13.75	5.00	0.2500	0.3125	11.50	7546.53	3.27	2.90E+07	0.0181	0.0639 ✓
W	21x44	20.63	6.50	0.3750	0.4375	23.25	4428.07	10.10	2.90E+07	0.0575	0.1292 ✓

MAX DEFLECTION 0.2549 IN.

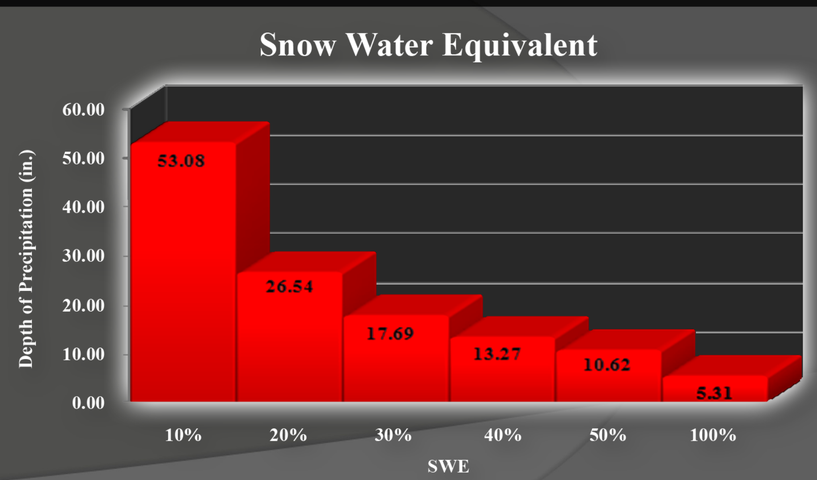
Green Roof Analysis

Roof Failure Caused by Snow Load
(Due to recent snowfall in the DC area)

Snow Water Equivalent

	SWE	Precip. (in. & ft.)
Typical 10-20% Winter and 20-40% Spring	10%	53.08" (4.42')
	20%	26.54" (2.21')
	30%	17.69" (1.47')
	40%	13.27" (1.11')
	50%	10.62" (0.89')
Water	100%	5.31" (0.44')

Note: 10% SWE when air temp. is near 14°F
20% SWE when air temp. is near 32°F
100% SWE indicates max. distance from primary drain to secondary



Presentation Outline

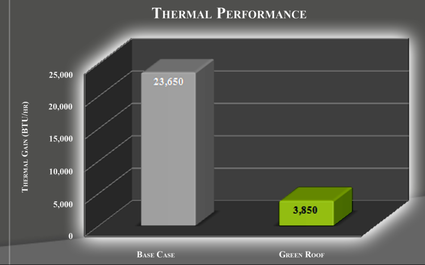
- § Project Overview
- § Overall Goal
- § Backup Generator Analysis
- § *Green Roof Analysis*
  - Area of Potential Improvement
  - Proposed Solution
  - Benefits and Drawbacks
  - Description of Existing Design
  - Proposed Changes
  - Structural Load Analysis
  - *Resulting Energy Savings*
  - Cost Analysis
  - Schedule and Constructability
  - Conclusion
- § Curtain Wall Redesign Analysis
- § Smart Power Strip Analysis
- § Summary of Findings
- § Acknowledgements

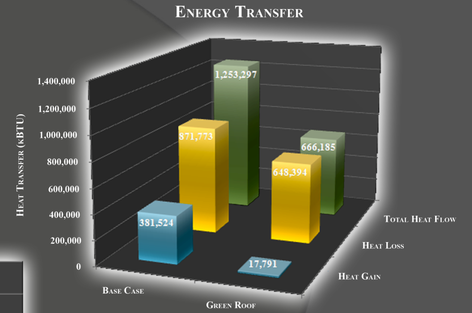
Green Roof Analysis

Energy Savings

Primarily Analyzed Conduction
Base Membrane Temperature:158°F
Green Roof Membrane Temperature: 86°F
Interior Design Temperature: 72°F

Thermal Performance
84% Reduction in Thermal Gain





- § PROJECT OVERVIEW
- § OVERALL GOAL
- § BACKUP GENERATOR ANALYSIS
- § *GREEN ROOF ANALYSIS*
  - AREA OF POTENTIAL IMPROVEMENT
  - PROPOSED SOLUTION
  - BENEFITS AND DRAWBACKS
  - DESCRIPTION OF EXISTING DESIGN
  - PROPOSED CHANGES
  - STRUCTURAL LOAD ANALYSIS
  - RESULTING ENERGY SAVINGS
  - *COST ANALYSIS*
  - SCHEDULE AND CONSTRUCTABILITY
  - CONCLUSION
- § CURTAIN WALL REDESIGN ANALYSIS
- § SMART POWER STRIP ANALYSIS
- § SUMMARY OF FINDINGS
- § ACKNOWLEDGEMENTS

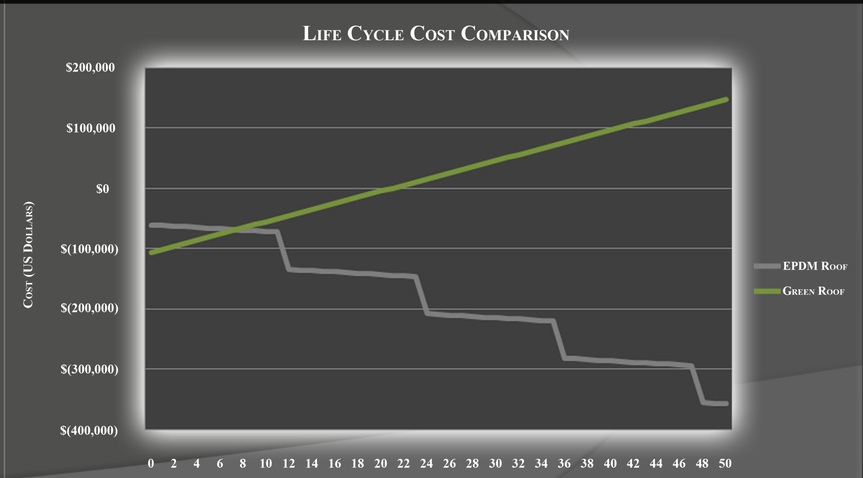
GREEN ROOF ANALYSIS

COST COMPARISON

EXISTING EPDM ROOF
COST PER SQUARE FOOT: $11.00
TOTAL INSTALLATION COST: $60,500
YEARLY SAVINGS: N/A
50 YEAR COST: $375,500
PAYBACK PERIOD: N/A

MODULAR GREEN ROOF
COST PER SQUARE FOOT: $19.26
TOTAL INSTALLATION COST: $105,900
YEARLY SAVINGS: $5,056
50 YEAR COST: $105,900
PAYBACK PERIOD: 20.9 YRS

RELATIVE PAYBACK PERIOD: 7.4 YRS



Green Roof Analysis

Schedule Impact

- *Installation time: 1 day (Based upon 5,000 sqft per day)*
- *Work could be performed on Weekend*
- *Therefore not impacting the overall project schedule*

Constructability Impact

- *Proposed modular system uses existing substrate*
- *Modules are easy to install into grid pattern*

Green Roof Analysis

Conclusion

Total Cost: $105,900
Payback Period: 20.9 yrs
Added Cost: $45,400
Payback Period: 7.4 yrs

Annual Energy Savings: $5,056

Cost per Square Foot New Construction: $3.14

CURTAIN WALL REDESIGN ANALYSIS

BUILDING FAÇADE ACCOUNTS FOR 75% OF BUILDING ENVELOPE

TYPICALLY ALL FOUR ELEVATIONS ARE TREATED THE SAME IN TERMS OF DESIGN

EACH ELEVATION RECEIVES DIFFERING AMOUNTS OF SOLAR GAIN AND THEREFORE SHOULD BE DESIGNED ACCORDINGLY

CURTAIN WALL REDESIGN ANALYSIS

REDESIGN THE BUILDING'S SOUTH AND WEST ELEVATIONS USING SUPER INSULATED GLAZING

Note: the information needed for this analysis was received relatively late in comparison to the other analyses and therefore this is only a partial analysis

CURTAIN WALL REDESIGN ANALYSIS

BENEFITS

CUSTOMIZING EACH ELEVATION BASED UPON SOLAR GAIN AND OTHER FACTORS CAN GREATLY INCREASE THE PERFORMANCE OF THE BUILDING ENVELOPE

DRAWBACKS

DOING SO RESULTS IN MULTIPLE DESIGNS WHICH ADD TIME AND INCREASE COST

CURTAIN WALL REDESIGN ANALYSIS

EXISTING DESIGN

NORTH:

BRICK VENEER WITH PUNCH WINDOWS

EAST:

BRICK VENEER WITH RIBBON WINDOWS

SOUTH AND WEST:

HARMON UNITIZED CURTAIN WALL SYSTEM
FULL STORY HEIGHT MODULES
U-VALUE: 0.31 BTU/HR-FT²-°F
SOLAR SHADING LOUVER SYSTEM

Image Provided by DAVIS Construction

CURTAIN WALL REDESIGN ANALYSIS

PROPOSED CHANGES

NORTH AND EAST:

UNCHANGED

SOUTH AND WEST:

SCHUCO UNITIZED CURTAIN WALL SYSTEM
FULL STORY HEIGHT MODULES
U-VALUE: 0.14 BTU/HR-FT²-°F

BUILDING INTEGRATED SOLAR COLLECTORS

TRANSLUCENT VISION GLASS COLLECTORS
SEMITRANSPARENT NON-VISION GLASS COLLECTORS

Presentation Outline

Curtain Wall Redesign Analysis

Energy Savings

45% Reduction during Summer
41% Reduction during Winter

167,323 kWhrs Annually
$132,641 Annually

****Based Upon Glazing Redesign (no solar collectors)***

Mechanical Load Calculations

			General Building Data				Summer				Winter				Reduction	
	Level	Elevation	Material	Length (ft)	Height (ft)	Area (ft^2)	U-Value [BTU/(hr-ft2-F)]	T_{out} (°F)	T_{in} (°F)	Heat Flow BTU/hr	U-Value [BTU/(hr-ft2-F)]	T_{out} (°F)	T_{in} (°F)	Heat Flow (BTU/hr)	Summer %	Winter %
Existing Design	9	North	Brick	134.86	13	1753.18	0.07	85	70	1737	0.07	46	68	-2548		
		East	Curtain Wall	73.88	13	960.44	0.07	85	70	952	0.07	46	68	-1396		
		South	Curtain Wall	136.91	13	1779.83	0.31	85	70	8276	0.29	46	68	-11355		
		West	Curtain Wall	60.39	13	785.07	0.31	85	70	3651	0.29	46	68	-5009		
	10	North	Brick	134.86	13	1753.18	0.07	85	70	1737	0.07	46	68	-2548		
		East	Curtain Wall	73.88	13	960.44	0.07	85	70	952	0.07	46	68	-1396		
		South	Curtain Wall	136.91	13	1779.83	0.31	85	70	8276	0.29	46	68	-11355		
		West	Curtain Wall	60.39	13	785.07	0.31	85	70	3651	0.29	46	68	-5009		
	11	North	Brick	134.86	13	1753.18	0.07	85	70	1737	0.07	46	68	-2548		
		East	Curtain Wall	73.88	13	960.44	0.07	85	70	952	0.07	46	68	-1396		
		South	Curtain Wall	136.91	13	1779.83	0.31	85	70	8276	0.29	46	68	-11355		
		West	Curtain Wall	60.39	13	785.07	0.31	85	70	3651	0.29	46	68	-5009		
										43846				-60922	N/A	N/A
Proposed Design	9	North	Brick	134.86	13	1753.18	0.07	85	70	1737	0.07	46	68	-2548		
		East	Curtain Wall	73.88	13	960.44	0.07	85	70	952	0.07	46	68	-1396		
		South	Curtain Wall	136.91	13	1779.83	0.14	85	70	3762	0.14	46	68	-5518		
		West	Curtain Wall	60.39	13	785.07	0.14	85	70	1659	0.14	46	68	-2434		
	10	North	Brick	134.86	13	1753.18	0.07	85	70	1737	0.07	46	68	-2548		
		East	Curtain Wall	73.88	13	960.44	0.07	85	70	952	0.07	46	68	-1396		
		South	Curtain Wall	136.91	13	1779.83	0.14	85	70	3762	0.14	46	68	-5518		
		West	Curtain Wall	60.39	13	785.07	0.14	85	70	1659	0.14	46	68	-2434		
	11	North	Brick	134.86	13	1753.18	0.07	85	70	1737	0.07	46	68	-2548		
		East	Curtain Wall	73.88	13	960.44	0.07	85	70	952	0.07	46	68	-1396		
		South	Curtain Wall	136.91	13	1779.83	0.14	85	70	3762	0.14	46	68	-5518		
		West	Curtain Wall	60.39	13	785.07	0.14	85	70	1659	0.14	46	68	-2434		
										24331				-35685	45	41

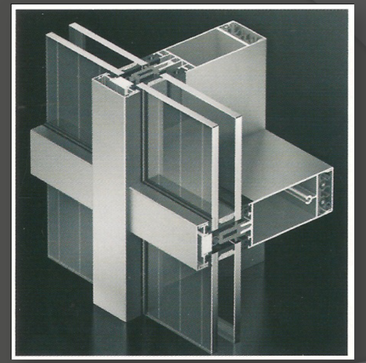
CURTAIN WALL REDESIGN ANALYSIS

COST COMPARISON BY DESIGN

Design	Initial Cost	Incentives	Annual Savings	Net Cost	Payback	Net Added Cost	Payback
Existing	$ 769,470.00						
Glazing Redesign	$ 846,417.00	$ 13,850.46	$ 132,641.08	$ 699,925.46	6.1	$ (69,544.54)	0.0
Non-Vision Only	$ 1,000,311.00	$ 46,850.46	$ 138,682.36	$ 814,778.18	6.4	$ (31,638.82)	0.0
Both Collectors	$ 1,231,152.00	$ 46,850.46	$ 152,623.79	$ 1,031,677.75	7.4	$ 262,207.75	1.7

INITIAL COST VERSUS ADDED COST

Design	Initial Cost	Added Cost	Annual Savings
Existing	$ 769,470.00		
Glazing Redesign	$ 846,417.00	$ 76,947.00	$ 132,641.08
Non-Vision Only	$ 1,000,311.00	$ 230,841.00	$ 138,682.36
Both Collectors	$ 1,231,152.00	$ 461,682.00	$ 152,623.79



Schuco FW50+.SI Curtain Wall System

(Image Provided by Schuco USA)

CURTAIN WALL REDESIGN ANALYSIS

SCHEDULE IMPACT

- *SIMILAR WEIGHT SYSTEMS WOULD RESULT IN THE SAME INSTALLATION TIME*
- *CONNECTION DETAILS ARE SIMILAR*

- *IF SOLAR COLLECTORS WERE INCORPORATED*
  - *CONNECTING PANEL WIRING TOGETHER*
  - *INSTALLING INVERTERS*
  - *CONNECTION TO BUILDING ELECTRICAL SYSTEM*

CONSTRUCTABILITY IMPACT

- *BOTH SYSTEMS CONSIST OF A INSULATING GLASS UNIT WITH TWO LITES OF THE SAME THICKNESSES*

**FURTHER RESEARCH WOULD BE NEEDED TO BETTER COVER THE TOPICS ADDRESSED IN THIS ANALYSIS*

SMART POWER STRIP ANALYSIS

MOST PEOPLE LEAVE THEIR COMPUTERS RUNNING CONTINUOUSLY WITHOUT EVER TURNING THEM OFF

SOME COMPUTERS ARE SET UP TO ENTER STAND-BY MODE WHEN NOT IN USE BUT THIS RESULTS IN MINIMAL ENERGY SAVINGS

SMART POWER STRIP ANALYSIS

REDUNDANCY

IF THE USER FORGETS TO PUT THE COMPUTER INTO SLEEP OR HIBERNATION MODE, PROGRAM THE COMPUTER TO DO SO

POWER STRIP RECOGNIZES POWER STATE OF COMPUTER AND CAN POWER OFF PERIPHERAL DEVICES AUTOMATICALLY

SMART POWER STRIP ANALYSIS

2175 K STREET
(FOUR HUNDRED COMPUTERS)

UNMANAGED COMPUTER
(ANNUALLY)

RUN TIME: 3.5 MILLION HRS
ELECTRICITY USAGE: 823,440 KWHR
ELECTRICITY COST: $127,057

MANAGED COMPUTER
(ANNUALLY)

RUN TIME: 832,000 HRS
ELECTRICITY USAGE: 195,520 KWHR
ELECTRICITY COST: $30,169

$96,888 SAVINGS ANNUALLY

BASE CASE
(ONE COMPUTER)

UNMANAGED COMPUTER
(ANNUALLY)

RUN TIME: 8,760 HRS
ELECTRICITY USAGE: 2,059 KWHR
ELECTRICITY COST: $317.64

MANAGED COMPUTER
(ANNUALLY)

RUN TIME: 2,080 HRS
ELECTRICITY USAGE: 489 KWHR
ELECTRICITY COST: $75.42

76% REDUCTION

SMART POWER STRIP ANALYSIS

- § PROJECT OVERVIEW
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- § GREEN ROOF ANALYSIS
- § CURTAIN WALL REDESIGN ANALYSIS
- § *SMART POWER STRIP ANALYSIS*
  - AREA OF POTENTIAL IMPROVEMENT
  - PROPOSED SOLUTION
  - ENERGY SAVINGS
  - *CONCLUSION*
- § SUMMARY OF FINDINGS
- § ACKNOWLEDGEMENTS

CONCLUSION

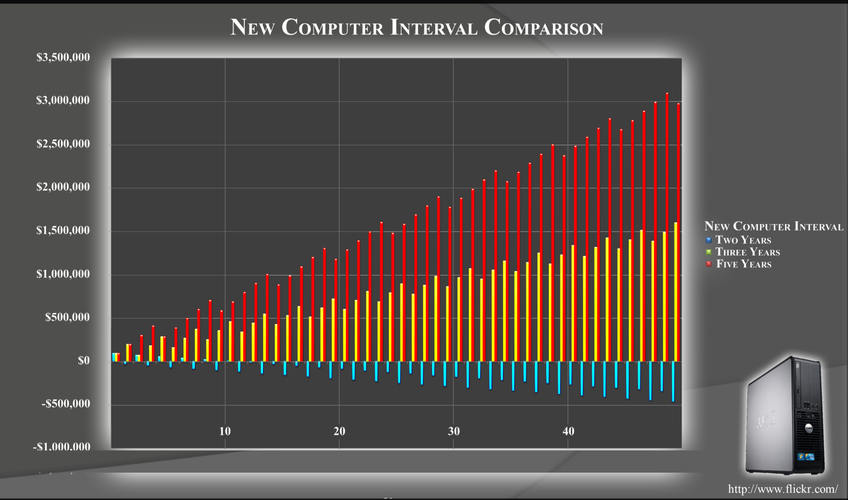
50 YEAR SAVINGS: $5.3 MILLION
($13,200 PER COMPUTER)

PAYBACK PERIOD: 1.4 MONTHS

NEW COMPUTER INTERVAL
5 YEAR: $284,700 (RED)
3 YEAR: $73,500 (YELLOW)
2 YEAR: -$32,000 (BLUE)

BREAKEVEN INTERVAL: 2.39 YEARS

(BASED UPON DELL OPTIPLEX 380 SFF WITH 22" MONITOR - $580.00)



- PROJECT OVERVIEW
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- GREEN ROOF ANALYSIS
- CURTAIN WALL REDESIGN ANALYSIS
- SMART POWER STRIP ANALYSIS
- *SUMMARY OF FINDINGS*
- ACKNOWLEDGEMENTS

SUMMARY OF FINDINGS

GRAND TOTALS:

ENERGY SAVINGS: 3,047,529 KWHR
ADDED COST: $744,279
COST SAVINGS: $378,583

PAYBACK PERIOD: 1.97 YRS

COST PER SQUARE FOOT:

	NEW CONSTRUCTION	TOTAL BUILDING
BACKUP GENERATOR	$16.31	$3.17
GREEN ROOF	$3.14	$0.61
GLAZING REDESIGN	$2.28	$0.44
SMART POWER STRIPS	$0.36	$0.07
	$22.09	$4.29

Energy Savings Summary		
Backup Generator	2,163,200	kWhrs
Green Roof	32,769	
Glazing Redesign	167,323	
Smart Power Strips	684,237	
	3,047,529	kWhrs

Added Cost Summary		
Backup Generator	$	549,412
Green Roof	$	105,924
Glazing Redesign	$	76,947
Smart Power Strips	$	11,996
	$	744,279

Cost Savings Summary			
Backup Generator	$	135,308	*
Green Roof	$	5,056	
Glazing Redesign	$	132,641	
Smart Power Strips	$	105,578	
	$	378,583	

Payback Period Summary	
Backup Generator	4.06 years
Green Roof	20.95
Glazing Redesign	6.07
Smart Power Strips	0.11

- Project Overview
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- Curtain Wall Redesign Analysis
- Smart Power Strip Analysis
- Summary of Findings
- Acknowledgements

AE 542: Building Enclosure Science and Design

Energy Transfer Equations and Design Principles

AE 597D: Sustainable Building Methods

Overall Energy Conservation Theme
Foundation for Backup Generator Analysis

AE 572: Project Development and Delivery Planning

Financial Models and Lifecycle Cost Analysis
Payback Period Analysis

ACKNOWLEDGEMENTS

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DENNIS COTTER	*EXECUTIVE VICE PRESIDENT*
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WILLIAM COX	*ASSISTANT PROJECT MANAGER*
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LESTER FUNKHOUSER	*SUPERINTENDENT*
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MINSHALL STEWART PROPERTIES

JOHN STEWART	*OWNER*
THADDEUS MINSHALL	*OWNER*

FOX ARCHITECTS

J. P. SPICKLER	*ARCHITECT*
BRAD KING	*ARCHITECT*
DAVID BUDDENDECK	*ARCHITECT*

THANK YOU

AND MOST OF ALL, MY FAMILY AND FRIENDS