University of Maryland, Baltimore

New Administration Building

Keith Meacham
Construction Management

Penn State AE Senior Thesis 2009

Outline

- Project Overview
- Goals and Conclusions
- Collegiate Reaction to Rising Energy Cost
- Building Envelope Analysis
  - Includes Depth and Mechanical Breadth
- Photovoltaic Implementation
  - Includes Electrical Breadth
- Recommendation
- Questions

Project Overview

- Location – Baltimore, MD
- Size – 107,000SF/6 Stories
- Schedule – March 2007 to September 2008
- Cost – $27.5 Million (Est.)
- Structure – Cast in Place Post-Tension Concrete
- Façade – Majority Brick with 878 SF Curtainwall

Outline

ANALYSIS 1

Collegiate Reaction to Escalating Energy Costs

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PROBLEM

- "US uses 25% of the world's energy making up only 5% of the world's population," Penn State University, OPP website.
- Colleges and universities are in a unique situation
  - 24hr labs and libraries
  - late classes
  - recreational facilities

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GOAL

- To compare 3 colleges of different sizes and locations and determine vital steps to beginning a conservation plan.

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Basics

- 62 buildings, 61 acres
  - dental/medical clinics, labs, libraries, administration offices
- 2/3 of building spaces require 100% OA
- 2006 signed American College & University Presidents Climate Commitment
- Part of PJM's (Pennsylvania – New Jersey – Maryland) Demand Response Program
- Between 06'-08' reduced electrical consumption by 20 million kWh

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AMERICAN COLLEGE & UNIVERSITY PRESIDENTS CLIMATE COMMITMENT

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Energy Projects

comverge Real – Time Economic Load Response Program

- Monitors 66,000 data points around campus

Capabilities

- Monitors real – time market pricing
- Develop load profiles
- Create Customer Baselines
- Energy audits to measure potential savings
- Metering and system integration
- Analyzing and graphing tools

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Energy Projects

Central Command Center

- Controls systems of all buildings on campus
- Schedule lighting and air flow

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Energy Projects

Looped Chill Water Plants

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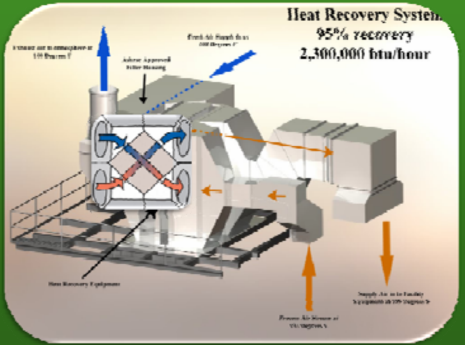
Energy Projects

Heat Recovery Systems



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New Construction

- LEED Energy Models
- Emphasis on Task Lighting

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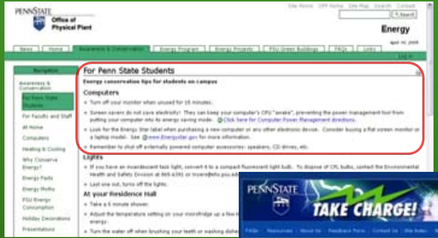
University Park Basics

- 647 buildings, 15,000 acres
- U.S. Environmental Protection Agency's (EPA) list of the top 10 college and university Green Power Partners
- Medlar Field at Lubrano Park
  - -first LEED Certified baseball stadium
- Energy Consumption (fiscal year 2005/2006)
  - 400,000,000 kWh of Electricity
  - 400,000 MCF of Natural Gas
  - 75,000 tons of Coal

Awareness



- energy.opp.psu.edu
- takecharge.psu.edu

Energy of Environmental Stewardship Presentations

- *Energy Planning 1-2-3*
- *Environmental Goals*
- *DIY Energy Savings*

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PENNSTATE 1855

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Energy Projects

Guaranteed Energy Saving Program (GESP)

- Very similar to ESCO
- **UP - Initial Project Phase I**
  - -investment of $2,212,937
  - -annual energy cost avoidance worth $230,416 (2002 energy dollars).

Atherton	Arts
Ceramics	Computer
Frear South	Mateer
Materials Research Lab	Mueller
Music	Noll
Osmond	Pattee/Paterno Library
Pond	Porter
Shunk	

Energy Savings (value of avoided energy in 2002 dollars)

Commodity	Savings	Avoided Cost
Electric	2.89M kWh	$127,403
Water	5.36M gallons	$31,933
Steam	5.88M pounds	$71,079

Avoided Emissions

Type	Amount
CO_2	1959 tons
NO_x	5 tons
SO_x	15 tons
CO	291 lbs
PM	587 lbs
VOCs	57 lbs

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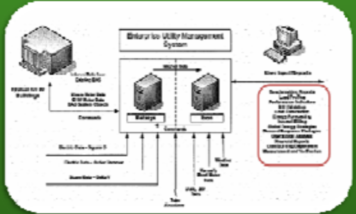
Energy Projects

Enterprise Utility Management Solution

- More than just a Building Automation System
- Data takes the form of diagnostics, analyses, and monitoring



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Energy Projects

Continuous Commissioning Program

Goals
- optimize the operation of existing systems
- improve building comfort within the capabilities of the installed system
- reduce building energy cost
- solve indoor air quality problems
- guarantee continuous optimal operation for years to come
- reduce operational and maintenance costs

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LACCD Basics

- 9 cities, 200,000 students
- Largest public sector sustainable building effort in the U.S.
- Signed

American College & University Presidents Climate Commitment

- Goal – "off the grid" by June '09

Energy Projects

Awareness: Sustainable Development Curriculum

- Training, Renewable Energy Curriculum, Hands on Experience

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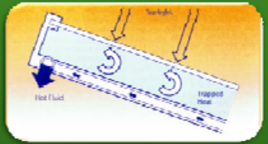
Energy Projects

Renewable Central Plant

- 1 on each of the 9 campuses



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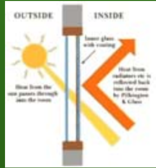
Energy Strategies

- Awareness: Sustainable Development Curriculum
- Renewable Central Plant
- Demand Management through Performance Contracts
  - Energy Service Company (ESCO)
  - Similar to GESP



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LOS ANGELES COMMUNITY COLLEGE DISTRICT

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American College & University Presidents Climate Commitment

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Energy Strategies

- Awareness: Sustainable Development Curriculum
- Renewable Central Plant
- Demand Management through Performance Contracts
- 1 MW Solar/PV per campus
  - Parking lot and roofs


East L.A. College's 1.2 MW solar farm

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Energy Plan Essentials

- Educate community, create awareness of what the school is doing and what the individuals can do to help
- If possible have one chiller plant
- Analyze existing buildings and determine best way to improve conservation
- Put buildings on lighting and HVAC schedules
- Monitor all buildings new and old to ensure systems are working properly

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ANALYSIS 2

Building Envelope and Space Heating Analysis – Mechanical Breadth Included

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PROBLEM

- Great amount of heat transfer through the building envelope
  - -Often where conservation efforts begins
- Space heating in the form of finned tube radiant heater s can lose a lot of heat through the fenestration

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- Space heating in the form of finned tube radiant heater s can lose a lot of heat through the fenestration

GOAL

- To compare multiple scenarios that attempt to make the building more efficient and select the one with the greatest savings
- Reduce the building's energy consumption through envelope improvements and analyzing the current space heating efficiency

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Existing Envelope Thermal Characteristics

Existing Wall Assembly		
Wall Construction	**Thickness**	**R-Value (ft² ·°F·hr/BTU)**
Brick Veneer	4"	0.44
Air Space	2"	1
Rigid Insulation	1"	5
Air Infiltration Barrier	-	-
Exterior Sheathing	5/8"	0.77
R-19 Batt Insulation	6.25"	17
Gypsum Board	5/8"	0.56
Total	13.75"	24.77
	U-Value (BTU/ft²·°F·hr) = 0.040	

	Existing Windows
U-value	
Winter	0.41
Summer	0.39
Shading Coefficient	0.44

	U-Value
Roof	0.033
Curtainwall	0.66

Proposed Envelope Thermal Characteristics

Existing Wall Assembly			Proposed Wall Assembly		
Wall Construction	**Thickness**	**R-Value (ft² ·°F·hr/BTU)**	**Wall Construction**	**Thickness**	**R-Value (ft² ·°F·hr/BTU)**
Brick Veneer	4"	0.44	Brick Veneer	4"	0.44
Air Space	2"	1	**Air Space**	1"	0.5
Rigid Insulation	1"	5	**Rigid Insulation**	2"	10
Air Infiltration Barrier	-	-	Air Infiltration Barrier	-	-
Exterior Sheathing	5/8"	0.77	Exterior Sheathing	5/8"	0.77
R-19 Batt Insulation	6.25"	17	**R-21 Batt Insulation**	5.5"	21
Gypsum Board	5/8"	0.56	Gypsum Board	5/8"	0.56
Total	13.75"	24.77	**Total**	13.75"	33.27
	U-Value (BTU/ft²·°F·hr) = 0.040			**U-Value (BTU/ft²·°F·hr) = 0.030**	

	Existing Windows	Proposed Clear Windows	Proposed Grey Windows
U-value			
Winter	0.41	0.25	0.25
Summer	0.39	0.2	0.2
Shading Coefficient	0.44	0.29	0.19

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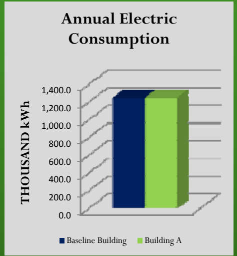
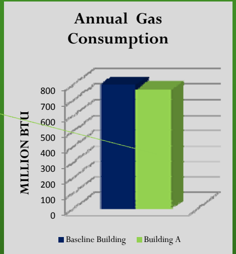
eQuest Comparison - Insulation



32.07 Million BTU/Yr (4%)



KEY		
	Baseline Building - This is the building that was constructed	
Building A – Baseline + Added Insulation	Building C – Baseline+ Viracon's VUE-50, GREY	Building E - Combination of Building A, B and D
Building B - Baseline + Viracon's VUE-50, CLEAR	Building D – Baseline-Finned Tube Heaters	Building F - Combination of Building A, C and D

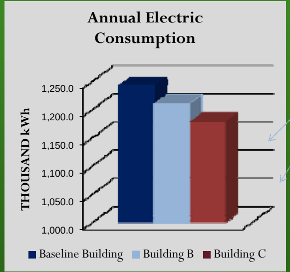
eQuest Comparison - Glazing

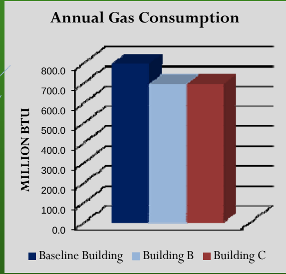
64,600 kWh/Yr (5%)

32,700 Thousand kWh/Yr (3%)

101.9 Million BTU/Yr (12.8%)

102.9 Million BTU/Yr (12.9%)





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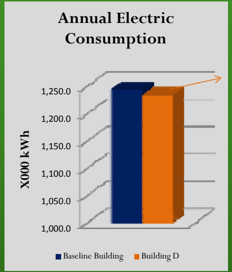
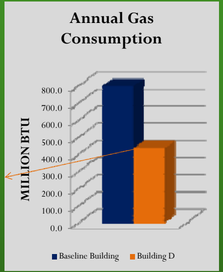
eQuest Comparison – Finned Tube Heater



10.5 Thousand kWh/Yr (.8%)

361.1 Million BTU/Yr (45.5%)



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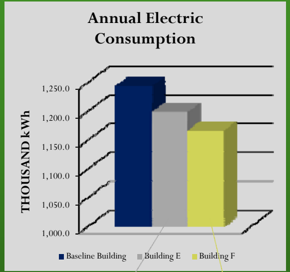
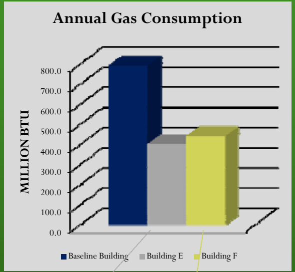
eQuest Comparison - Combination





44.9 Thousand kWh/Yr (3.6%)

76.9 Thousand kWh/Yr (6.2%)

391.1 Million BTU/Yr (49%)

350.3 Million BTU/Yr (44%)

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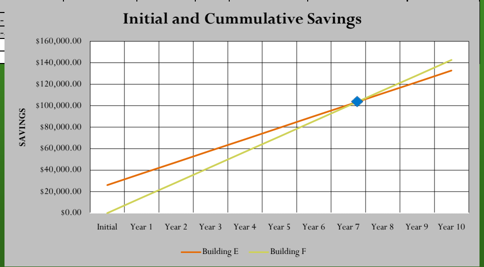
Cost and Schedule Implications

Annual [illegible] Savings

	Total Material Cost	Total Material Savings	Total Installation Savings	Total Annual Energy Savings	Total Initial Savings	Savings After 1 Yr
Building E	$94,276	$350,852	$77,789	$10,677	$334,365	$345,042
Building F	$120,416	$350,852	$77,789	$14,266	$308,225	$322,491



Cost and Schedule Implications

Installation Savings

	Amount of Work (LF)	Total Days Required
HVAC PIPING LOOP - MAINS & BRANCHES	-	80
SET/CONNECT FIN TUBE HEATER	3437	52

	Amount of Work (LF)	Total Days Required
FIN TUBE RADIATION PIPING	6900	48
SET/CONNECT FIN TUBE HEATER	3437	52

	Amount of Work (LF)	Durations (Days)	Crew Size	Combined Wage (/day)	Total Savings
Fin Tube Radiation Piping	6900	48	4	$1,051.20	$50,457.60
Set/Connect Fin Tube Heater	3437	52	2	$525.60	$27,331.20

Time Saved	20 Weeks
Labor Saved	$77,788.80

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ANALYSIS

Photovoltaic Implementation – Electrical Breadth Included

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PROBLEM

- Owner would like to explore conservation through renewable energy

GOAL

- Design a photovoltaic system that will be efficient and yield a savings after a short payback period.

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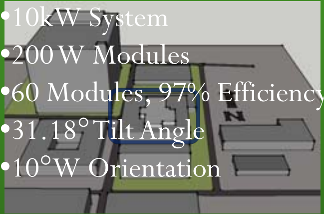
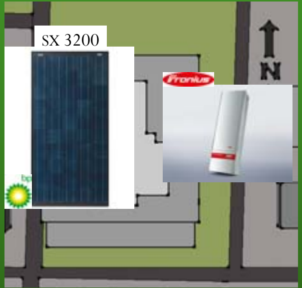
Array Size and Configuration

Site Analysis

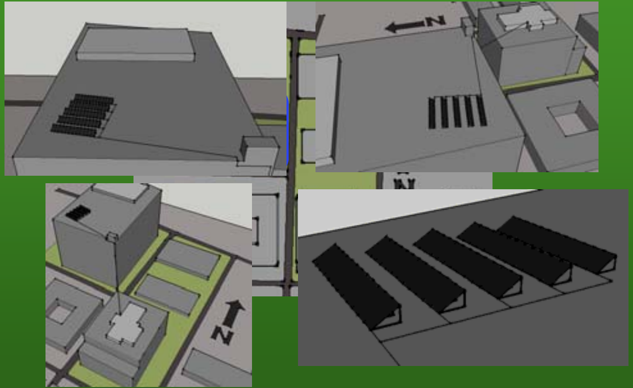
- 10kW System
- 200 W Modules
- 60 Modules, 97% Efficiency
- 31.18° Tilt Angle
- 10° W Orientation





Array Size and Configuration

Proposed Site



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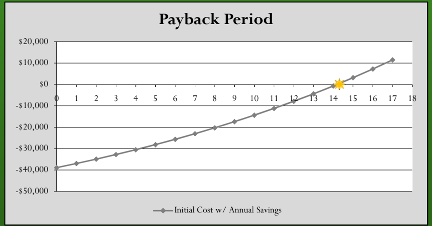
Cost Analysis

- $7/Watt
- $14,000/month Est.
- 40% Paid by Incentive
- 12,571 kWh Produced Annually
- Savings of $1,949 Annually
- Approximately 14yr Payback

Benefits of your BP Solar system	
Estimated System Cost	$70,000
Federal / State Tax Credit	$21,107
State / Utility Rebate	$10,000
Net Cost	$38,893
Cumulative Lifetime Savings	$93,000 over 25 years
Investment Return	7.8%



Conclusion

- The relatively short payback period and education value makes the photovoltaic implementation practical