AEE December Luncheon
Green Revolving Fund for Energy Efficiency

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(12/08/11)
Caltech Overview

- Private research university in Pasadena, CA
- Campus population roughly 6,000
- 120+ GWH electricity annually
- 60% generated in CoGen
- Energy Intensity ~300 MBTU/SF
  - Average UC Campus ~ 180 MBTU/SF
- $20M+ annual utility bill
- 4.1 Million SF of buildings
- 125 acres in urban setting
Historical Power Consumption by Source (1990-2011)

- Purchased
- Generated Onsite
Energy decisions are traditionally made on a cost versus benefit basis. This discussion will outline the approach taken by the California Institute of Technology (Caltech) utilizing specific examples of energy efficiency measures and the decision making processes to support them. The discussion will overview Caltech’s energy project financing mechanism and preview tools being developed to ensure persistent efficiency benefits beyond project completion.
Outline

• Risk mitigation strategies; how to keep a balanced energy project portfolio to enable financial return without risk to utility budgets, what operational controls should be considered.

• Forecasting project avoided costs to make the case for access to capital.

• Operational reporting, how to “true-up” stipulated savings against budgets, when is metering necessary, when are the calculations sufficient.

• Deciding what technologies to pursue, what order to release projects and how to keep the green revolving fund from running out of low-hanging fruit.
The Billion Dollar Green Challenge is transforming energy efficiency upgrades from perceived expenses to high-return investment opportunities. 

Learn More »

$1 Billion Green Challenge Launches

October 11, 2011

The Billion Dollar Green Challenge was launched today at the AASHE 2011 conference. The Challenge invites colleges to invest a total of one billion dollars in self-managed green revolving funds that finance energy efficiency upgrades.

Source: http://greenbillion.org

Greening the Bottom Line

Results of the first survey ever conducted about green revolving funds with data from more than 50 colleges.
Opportunity

Developing valuation of carbon
i.e. the inevitable utility pass through of cost

Carbon reduction is manageable with an aggressive energy retrofit strategy and efficient operations!
LEED EB: O+M CREDIT CATEGORIES
• **EA Prerequisite 2** Minimum Energy Performance

• **Intent:** Establish the minimum level of operating energy efficiency performance relative to buildings of similar type...

• **Requirements:** If eligible for Energy Star Rating, achieve rating of at least 69
  - If not eligible for Energy Star, demonstrate energy efficiency at least 19% better than comparable buildings
LEED EB: O+M Performance Period

Proposed Schedule for EB: O&M Initial Certification

- **Start Date**
- **Performance Period End Date**
- **Application Due**

**Plan & Program Development**
- Month 1
- Month 2
- Month 3
- Month 4
- Month 5
- Month 6
- Month 7
- Month 8
- Month 9
- Month 10
- Month 11
- Month 12
- Month 13
- Month 14

**Performance Period for EAp2 & EAc1**

- **Source MMBTU (w/o MRIs)**
- **Monthly Target - MMBTU (w/o MRIs)**
- **21%**
- **23%**
- **25%**

*All performance periods must end within the same 7-day interval.*

**Certification applications must be submitted w/in 80 calendar days of the end of the performance periods.**

**Minimum duration = 3 months; maximum duration = 24 months.**

**Minimum duration = 12 months; maximum duration = 24 months.**

Broad Center - Built 2002 - 125K SQFT
Project Funding
Caltech has created the Caltech Energy Conservation Investment Program (CECIP) to finance energy efficient infrastructure projects in order to reduce Caltech’s energy costs.

Projects Must:
- Exhibit verifiable savings
- Contain a plan for periodic measurement & verification
- Have a simple payback of 6 years or less

<table>
<thead>
<tr>
<th></th>
<th>FY09</th>
<th>FY10</th>
<th>FY11</th>
<th>FY12 (projected)</th>
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<tbody>
<tr>
<td>Energy Project Investment</td>
<td>$970K</td>
<td>$3.8M</td>
<td>$3.5M</td>
<td>$3.7M</td>
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<tr>
<td>Utility Rebates/Incentives</td>
<td>$350K</td>
<td>$500K</td>
<td>$600K</td>
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<tr>
<td>Reduced Utility Cost</td>
<td>$410K</td>
<td>$930K</td>
<td>$990K</td>
<td>$550K</td>
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<tr>
<td>Percent Annual Utility Cost</td>
<td>2%</td>
<td>6%</td>
<td>6%</td>
<td>4%</td>
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</table>
CECIP Paybacks

Project Commitments (ITD) ~ $10M
Utility Incentives ~ $2M
Avoided Utility Expense ~ $2M

SPB ~ 5 Yrs (w/o incentives)
ROI ~ 20% (w/o incentives)
Strategy
It’s worth the time to un-pack rates and use time-value of money

$/kWH

Simple Payback

We’re often tempted to lead with these
It’s worth the time to un-pack rates and use time-value of money

We should use these:

- $/kW/Month
- $/kWH (peak, summer/winter)
- $/kWH (off-peak, summer/winter)

Net Present Value
Modified Internal Rate of Return
What do we spend $ on for the deeper dive

Understand how the organization is structured
“how is what I am offering going to make you do your job more efficiently”

Training not just on what was installed but on the intent of operation (energy conservation measures)

Ask solution providers to identify Key Performance Indicators
Projects
Existing T8 fluorescent bulbs

New LED bulbs
50% energy savings

LED Lighting Retrofit, Campus Parking Structure
LED Lighting Retrofit, Campus Parking Structure

- $25K Implementation cost
- $9K Annual avoided costs
- $11K Rebate
• Replace old Low-Pressure Sodium Lighting in Holliston with new efficient Bi-Level Lighting
• Reducing the electrical consumption while at the same time enhancing safety in the structure

15% of the Project cost is being funded from the Energy Technology Assistance Program ETAP Grant awarded to Caltech.

ETAP goal is to accelerate the adoption of advanced energy efficiency technologies in California.
TO DATE:
1 MW Reduction

IN PROGRESS:
.103 MW Reduction
Data Center, Hot/Cold Aisle Retrofit and HVAC Controls

Hot/Cold Aisle – kBtu Chilled Water

FY 2010  FY 2011

kBtu

0  100,000  200,000  300,000  400,000  500,000  600,000  700,000

October November December January February March April May June July August September
Air-Handler Control Valve Replacement & Building Controls

$800K Investment, $240K Rebate, $200K/Yr Savings
Broad Center - Built 2002 - 125K SQFT

$800K Investment, $240K Rebate, $200K/Yr Savings
Before

Air Handler Fan Replacements & Economizer Sections
Air Handler Fan Replacements & Economizer Sections

$50K Per Year Avoided Cost
DEED Grant for the American Public Power Association
“Evaluation on Tek-Air Accuvalve in Retrofit Applications – Demonstration of Energy Efficiency Operations Benefits and Relevance Across Multiple Target Markets”

Location:
South Mudd Victoria Orphan Lab (0075)

Purpose:
Retrofit of a Constant Volume to a low-pressure drop design.

Objective:
Document energy efficiency benefits and system versatility, assess feasibility across campus and other markets
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Document energy efficiency benefits and system versatility, assess feasibility across campus and other markets.
Location:
South Mudd Victoria Orphan Lab (0075) and Beckman Inst. Lab (244)

Purpose:
Retrofit existing Fume Hoods to Auto Closing

Objective:
A recent study by Southern California Edison indicates that a fume hood is used only 9% of the time that it is in the open position. While this will vary location to location, for the subject laboratory at Beckman Institute the chart below shows the potential time a set-back could be in place should the ASPS be installed. In a variable volume system this equates to a nearly 90% potential for local air-flow reduction via face-velocity set-back.
DEED Grant for the American Public Power Association

Pneumatic to Digital Building Controls Upgrades

Before

• Local control
• No data available for optimization

After

• Local control
• Data available for optimization
• Uses existing infrastructure
Retro-Commissioning: When a deeper dive is needed

Definition:
A process to optimize building system performance
Projects Must:
- Exhibit verifiable savings
- Contain a plan for periodic measurement & verification
- Have a simple payback of 6 years or less
Retro-Commissioning: $/SQFT Avoided Cost

Total $ per Square Foot per Year

100% Outside Air i.e. Lab Spaces

Recirculating Air i.e. Office Space

$/SQF (per utility)

CHW ($/sf-yr)

HHW/ steam ($/sf-yr)

Elec ($/sf-yr)

Before Retro-Commissioning: $/SQFT Avoided Cost

100% OA

Recirc

$0.00

$1.00

$2.00

$3.00

$4.00

$0.00
Caltech is its own micro-grid with a diverse portfolio of energy generators. The portfolio supports the energy needs of Caltech while being less carbon intensive than traditional purchased electrical power.
Solar PV: Zero Upfront Cost, Power Purchase Agreements

1.3 MW
3 Parking Structures
8 Buildings
Typical 100 KW unit

- No AQMD Permit
- No Heat Recovery
- Cleaner than PWP

Cells at Central Plant
Co-Generation

- DOE EPA Award winning plant
- 4th generation Co Gen since 1980
- Generate 70-80% of our campus electricity
Active Energy Management

“Building energy usage creeps up 3% per year” in a post-retrofit period.

*California Energy Commission – Public Interest Energy Research Program, 2003*
Optimization through traditional controls
Put it all together with Active Energy Management via EEM

• Simplify the process of transforming data to knowledge
• Make your operations’ staff more efficient
• Locate efficiency outliers as they are occur and before they impact your budget, your carbon reduction goal and your performance period!
Optimization through outlier analysis & modeling
Enterprise Energy Management

- BAS
- Metering Systems
- Work Orders
- Efficiency Investments
- Weather data
- Scheduling
- Plant operations
Putting it all Together

Budgeting and Tracking
Monthly KWh vs predictions vs CDDs

FY-11 Budgted vs. Actual (kWh)

Complex, Accurate budget, with ECM predictions of Avoided Cost
Historical Power Consumption

Historical Power Consumption by Source (1990-2011)

- Purchased
- Generated Onsite

MWH

Historical Power Consumption

Nearly 500K SQFT Growth, ~Zero kWh Growth

Chilled Water (MMBtu x 10)

Significant Cooling Load Reduction
INTEGRATE

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