

Example LEED-NC v2.1 Energy & Atmosphere Credit 1 Submittal

November 2004

The following documentation provides an example submittal for the LEED-NC v2.1 Energy & Atmosphere Credit 1 (EAc1). This sample EAc1 submittal includes the following elements:

1. Signed LEED Letter Template (Pg 2).
2. Summary statement, as requested in the LEED reference guide, presenting the energy efficiency measures incorporated in the building design. The summary includes both a narrative and a description of energy simulation inputs as follows:
 - a. A narrative describing building systems (i.e. type of HVAC, lighting, hot water, etc.), and listing the major energy efficiency measures (Pg 3-4);
 - b. A table presenting major energy simulation inputs for both the ECB and DEC (Pg 5-6);
3. Output from the energy simulation package demonstrating that the Design Energy Cost is lower than the Energy Cost Budget as defined in ASHRAE 90.1-1999, Section 11. The output presents all the information requested by the ASHRAE/IESNA 90.1-1999, Section 11 ECB. This requirement is most effectively satisfied by submitting the following:
 - a. A narrative description of major discrepancies between the budget and design energy case pertaining to number of warnings, and percentage of hours any zone is outside of the throttling range (Pg 6)
 - b. Page 1 of the Energy Cost Budget Compliance Report from the ASHRAE 90.1-1999 User's Manual (Pg 7)
 - c. A LEED energy summary by end use based on the "EAp2, EAc1 & EAc2" sheet of the LEED calculator (Pg 8).

For this example submittal, a hypothetical building with the many common energy efficiency measures was simulated to elucidate nuances in the LEED-NC v2.1 EAc1 calculation protocol. The design and location were assembled to be representative of an EAc1 submittal that covers many of the energy simulation topics project teams may encounter in pursuing LEED-NC v2.1 EAc1.

This example documentation was prepared by CTG Energetics, Inc. for the U.S. Green Building Council.



vandalay
industries

EA Credit 1.1-1.10: Optimize Energy Performance

(Architect, HVAC Engineer or Responsible Party)

I, Art Vandalay, declare the following reduction in design energy cost compared to the energy cost budget for energy systems regulated by ASHRAE/IESNA Standard 90.1-1999 (without amendments):

New Buildings	Existing Buildings
<input type="checkbox"/> 15%	<input type="checkbox"/> 5%
<input type="checkbox"/> 20%	<input type="checkbox"/> 10%
<input type="checkbox"/> 25%	<input type="checkbox"/> 15%
<input type="checkbox"/> 30%	<input type="checkbox"/> 20%
<input type="checkbox"/> 35%	<input type="checkbox"/> 25%
<input checked="" type="checkbox"/> 40%	<input type="checkbox"/> 30%
<input type="checkbox"/> 45%	<input type="checkbox"/> 35%
<input type="checkbox"/> 50%	<input type="checkbox"/> 40%
<input type="checkbox"/> 55%	<input type="checkbox"/> 45%
<input type="checkbox"/> 60%	<input type="checkbox"/> 50%

I have provided the following to documentation to support the declaration:

- quantitative summary table (as per LEED reference Guide) showing the energy saving measures incorporated in the building design. The summary table includes detailed data on both design and budget assumptions.
- summary printout from an energy simulation package demonstrating that the design energy cost is lower than the energy cost budget as defined in ASHRAE/IESNA 90.1-1999, Section 11. The summary printout contains all the information requested by the ASHRAE/IESNA 90.1-1999, Section 11 ECB.


EA Cr 1 (10 possible points): Optimize Energy Performance

Points Documented
6

Name: Art Vandalay

Organization: Vandalay Industries

Role in project: Architect

Signature: 

Date: 12/3/2004

File last modified: August 1, 2003

Jamieson Academic Building

LEED-NC v2.1 EAc1

A. Project Narrative:

The new Jamieson Academic Building performs 44 % better than ASHRAE 90.1-1999 requirements using the LEED Energy Cost Budget methodology. This earns 6 LEED points.

The Jamieson Academic Building consists of two structures connected by a central stairwell. The first structure is a three-story, 68,000 square foot classroom building; the second structure is a three-story 22,000 faculty office building. The office building is mostly steel-frame construction. The west wall of the office building, and the entire classroom building are concrete construction. Three built-up VAV air handling units with chilled water provided from the campus central plant provide cooling and ventilation to the buildings; heating is provided through VAV reheat coils in each zone supplied by a central boiler. Lighting consists mostly of direct/indirect pendant mounted fluorescent fixtures in offices and classrooms, and compact fluorescent fixtures in hallways and other support spaces.

Both the budget and design energy cases were modeled in eQUEST (version 3.51), an energy simulation program, created by James J. Hirsch & Associates, which calculates the heating and cooling loads and the building energy usage for each hour of the year.

Note to LEED Documentation Authors: Please indicate the software used to prepare the calculations.

The energy rates used for both the budget and as-designed cases were based on local utility rates including the City of Burbank Public Service Department commercial rate for electricity and the Southern California Gas Company GN-10 rate for natural gas. Chilled water rates for both the standard and proposed case were \$9.75/MBTU based on an assumed central plant energy usage (for chillers, cooling towers, and pumps) of 1.0 kW/ton, and an average electricity cost of \$0.117/kWh.

Note to LEED Documentation Authors: If local utility rates are used, these should be referenced as shown above. If the Commercial Sector Average Energy Rates by State from the LEED Reference Guide are used, this should be stated clearly in the project documentation.

The analysis was based on U.S. climatic data for Burbank / Hollywood (Table D-1 of ASHRAE 90.1-1999), and the building envelope requirements prescribed in Table B-6 of ASHRAE 90.1-1999. The TMY2 weather file for Burbank, CA (burbanca.bin) was used for the analysis.

Note to LEED Documentation Authors: Please indicate the climate zone used for the analysis.

B. Building Energy Efficiency Measures:

1. High Efficiency Lighting: Average lighting power density for the office structure is 0.805 W/sf versus 1.3 W/sf allowed by ASHRAE 90.1-1999 using the Building Area Method for offices. Average lighting power density for the classroom building is 0.93 W/sf versus 1.5 W/sf allowed by ASHRAE 90.1-1999.

2. Lighting occupant sensor controls: The private offices (offices less than 250 square feet) in the office structure use lighting occupant sensor controls to switch off the lighting whenever the offices are unoccupied. A credit interpretation request for EAc1 submitted 12/2/2003, and ruled upon 2/4/2003 states that it may be possible to arrive at a reasonable estimate for lighting occupant sensor controls by manipulating the lighting power densities in the proposed case. This project has adopted a 20% lighting power density credit for occupant sensor controls in private offices. By applying this modeling methodology, occupant sensor control credits in the office building reduce the lighting power density from 0.805 W/sf to 0.739 W/sf.
3. Daylighting controls: one half of the fixtures in the classroom building are controlled with photosensors and continuously dimmable ballasts.
4. Additional Insulation: The U-value for mass walls on the two structures is 0.074 versus 0.580 allowed by ASHRAE 90.1-1999. This is accomplished by adding rigid R-10 insulation on the interior surface of the mass wall.
5. High Efficiency Glazing: The assembly U-value for the fenestration ranges from 0.42 to 0.60 versus 1.22 allowed by ASHRAE 90.1.
6. Variable Speed Drives on fans smaller than 25 hp. Fans smaller than 25 horsepower have variable speed drives in the design energy case, but per ASHRAE 90.1-1999, they are modeled as forward curve centrifugal fans with inlet guide vanes.
7. Variable Speed Drives on Chilled Water and Hot Water pumps – the chilled water and hot water pumps serving the buildings are controlled by variable speed drives, rather than single speed pumps required by ASHRAE 90.1-1999
8. Photovoltaics: A 35 kW (rated DC power) photovoltaic system is installed on the building, producing an average 45,075 kWh of energy (AC output) annually. This number was calculated using eQUEST's solar photovoltaics calculation after inputting the properties of the photovoltaics modules and the two inverters.

Note to LEED Documentation Authors: Energy efficiency measures such as demand control ventilation that must be modeled using the exceptional calculation method (ASHRAE 90.1-1999, section 11.5) should be reported similarly to renewable energy. See the row titled "*Renewable Photovoltaics (REC)*" in the *Energy Summary By End Use* table on Page 8 for an example.

C. Description of Differences Between ECB and DEC Case

The Design Energy Cost case had one software warning, and the Energy Cost Budget case had 4 software warnings. All of these warnings state that a certain zone :

- “has insufficient ZONE HEATING-CAPACITY plus BASEBOARD-RATING to maintain the specified DESIGN-HEAT-T for the calculated peak ZONE load.”

The worst-case zone in the budget case is a North classroom. This zone is under-heated 40 hours out of the year in the Energy Cost Budget case and 0 hours per year in the Design Energy Cost case. This is within the 50 hour per year limit required by ASHRAE 90.1-1999.

D. Comparison of Budget Design versus Design Energy Case

Building Element:	Building Design (Design Energy Cost case)	ASHRAE 90.1-1999 Prescriptive Requirement (Energy Cost Budget case)
BUILDING ENVELOPE		
Wall Construction	<ul style="list-style-type: none"> Office (most): R-21 Steel-frame wall, U-factor = 0.097 Office (west): 8" concrete furred out with metal furring and R-21 batt insulation; U-factor = 0.074 Classrooms: 8" concrete furred out with metal furring and R-21 batt insulation, U-factor = 0.074 	<ul style="list-style-type: none"> Office (most): R-13 Steel-frame wall, U-factor = 0.124 Office (west): Mass Wall, U-factor = 0.580 Classrooms: Mass Wall, U-factor = 0.580
Opaque Doors	<ul style="list-style-type: none"> Hollow Metal Door, U-factor = 0.580 	<ul style="list-style-type: none"> U-factor = 0.700
Windows	<ul style="list-style-type: none"> 21% window-to-wall ratio (including glass doors) Metal Frame, Double-Pane low-E glass (some fritted) U-value = 0.42 to 0.60 SHGC = 0.40 to 0.44 	<ul style="list-style-type: none"> 21% window-to-wall ratio (including glass doors) U-value = 1.22 SHGC = 0.25 (Non-North) SHGC = 0.61 (North)
Floor	<ul style="list-style-type: none"> Uninsulated 6" concrete Slab-on-Grade F-0.730 	Uninsulated 6" concrete Slab-on-Grade F-0.730
Roof	<ul style="list-style-type: none"> R-21 built-up roof, U-factor = 0.043 	<ul style="list-style-type: none"> R-15 built up roof, U-factor = 0.063
ELECTRICAL SYSTEMS		
Lighting Power Density	<ul style="list-style-type: none"> Office Structure: 0.805 W/sf average Classroom Structure: 0.93 W/sf average 	<ul style="list-style-type: none"> Office Structure: 1.3 W/sf Classroom Structure: 1.5 W/sf
Lighting Occupant Sensor Controls	<ul style="list-style-type: none"> Occupant sensor controls in private offices; modeled as 20% reduction in lighting power density; results in LPD for the office building of 0.739 W/sf. 	<ul style="list-style-type: none"> No occupant sensor controls
Lighting Daylighting Controls	<ul style="list-style-type: none"> Daylighting controls (photo sensors and dimmable ballasts) for 50% of fixtures in classrooms. 	<ul style="list-style-type: none"> None
Equipment Power Density*	<ul style="list-style-type: none"> 1.5 W/sf in offices 1.0 W/sf in classrooms & labs 	<ul style="list-style-type: none"> 1.5 W/sf in offices 1.0 W/sf in classrooms & labs
Exterior lighting*	<ul style="list-style-type: none"> 3.1 kW controlled via photocell (on from dusk to dawn) 	<ul style="list-style-type: none"> 3.1 kW controlled via photocell (on from dusk to dawn)
RENEWABLE ENERGY SYSTEMS		
Photovoltaics	<ul style="list-style-type: none"> 35 kW (DC) at a 5 deg. tilt, oriented South. Inverter efficiency = 84%. 	<ul style="list-style-type: none"> None
<p>Note to LEED Documentation Authors: Always include a description of renewable energy systems used to reduce design energy cost.</p>		
SCHEDULES		
Occupancy, Lighting & Equipment	<ul style="list-style-type: none"> Monday through Friday 8AM to 7PM, Saturday 8AM to 2PM 	<ul style="list-style-type: none"> Monday through Friday 8AM to 7PM, Saturday 8AM to 2PM
HVAC	<ul style="list-style-type: none"> Monday through Friday 6AM to 7PM, Saturday 6AM to 2PM 	<ul style="list-style-type: none"> Monday through Friday 6AM to 7PM, Saturday 6AM to 2PM

* Note: Unregulated loads

D. Comparison of Budget Design versus Design Energy Case (Continued)

Building Element:	Building Design (Design Energy Cost case)	ASHRAE 90.1-1999 Prescriptive Requirement (Energy Cost Budget case)
MECHANICAL & PLUMBING SYSTEMS		
HVAC System Type	<ul style="list-style-type: none"> AHU-1, AHU-2 (classrooms), and AHU-3 (offices) are VAV with HW reheat. FCU- 1, 2, and 3 (telecommunications rooms) are 4-pipe fan coils. Chilled water for AHUs and FCUs provided by a remote central plant (modeled as a CHW meter). Heating hot water for all AHUS and FCUs is provided by a boiler in the building. 	<ul style="list-style-type: none"> Same as Design Energy Case per Figure 11.4.3 and Table 11.4.3a in ASHRAE 90.1-1999. System types selected from Table 11.4.3a include: <ul style="list-style-type: none"> System 4: AHU-1, AHU-2 & AHU-3 System 7: FCU-1,2, and 3
Air-Side Economizer Controls	<ul style="list-style-type: none"> Enthalpy-based air-side economizers for AHU-1, AHU-2, AHU-3. 	<ul style="list-style-type: none"> Air-side economizer not required. Ventilation rate is constant
AHU Fan Properties	<p>All AHUs:</p> <ul style="list-style-type: none"> 3" total fan static pressure Mechanical efficiency: 72% <p>AHU-1 (Office) & AHU-2 (Flr 1 Classroom):</p> <ul style="list-style-type: none"> Motor Efficiency: 93% Variable Speed Drive (Drive Efficiency: 97%) Supply Air Flow: 20,000 cfm <p>AHU-3 (Flr 2&3 – Classroom Structure):</p> <ul style="list-style-type: none"> Motor Efficiency: 93.6% Variable Speed Drive (Drive Efficiency: 97%) Supply Air Flow: 40,000 cfm 	<p>All AHUs:</p> <ul style="list-style-type: none"> 3" total fan static pressure Mechanical efficiency: 72% <p>AHU-1 (Office) & AHU-2 (Flr 1 Classroom):</p> <ul style="list-style-type: none"> Motor Efficiency: 91.0% Forward-curve fan with inlet vanes Supply Air Flow: 20,000 cfm <p>AHU-3 (Flr 2&3 – Classroom Structure):</p> <ul style="list-style-type: none"> Motor Efficiency: 92.4% Variable Speed Drive (Drive Efficiency: 97%) Supply Air Flow: 40,000 cfm
Boiler Efficiency	<ul style="list-style-type: none"> 80% 	<ul style="list-style-type: none"> 80%
Central Plant Efficiency	<ul style="list-style-type: none"> Not Applicable since CHW is provided from the campus plant 	<ul style="list-style-type: none"> Not Applicable since CHW is provided from the campus plant
<p>Note to LEED Documentation Authors: Central plant efficiencies and capacities for chillers and cooling towers should be listed whenever the central plant is included as part of the energy model</p>		
HVAC Circulation Loop Properties	<ul style="list-style-type: none"> Same as ASHRAE 90.1-1999 prescriptive requirements except that both the CHW and HHW pumps have variable speed drives and both chilled and hot water loops are variable flow. 	<ul style="list-style-type: none"> Chilled water loop is constant flow CHW Pump Head: 50 feet CHW Pump Efficiency: 70.6% (motor + impellar) Hot water loop is a constant flow HW Pump Head: 60 feet HW Pump Efficiency: 65.8% (motor + impellar)
Domestic Water Heating	<ul style="list-style-type: none"> One 100-gallon natural gas storage water heater with 80% thermal efficiency 	<ul style="list-style-type: none"> One 100-gallon natural gas storage water heater with 80% thermal efficiency

Project Name:	Jamieson Academic Building	Date:	October 5, 2004
Project Address:	1612 Overture Dr.	Telephone:	818-498-2172
Designer of Record:	Dr. Van Nostrand	Telephone:	818-239-4294
Contact Person:	A. Vandalay	Principal Heating Source: <input checked="" type="checkbox"/> Fossil Fuel	
City:	Burbank, CA	<input type="checkbox"/> Electricity	<input type="checkbox"/> Solar/Site Recovered <input type="checkbox"/> Other
Weather Data:	Burbank CA (Burbanca.bin)		
Energy Code:	ASHRAE 90.1 1999		

Space Summary

Building Use	Conditioned Area (sf)	Unconditioned (sf)	Total (sf)
1. Classroom	50,500		50,500
2. Storage	3,000		3,000
3. Restroom	2,000		2,000
4. Office	15,000		15,000
5. Corridor	12,500		12,500
6. Conference	2,000		2,000
7. Mechanical/Electrical		2,000	2,000
8. Indoor Stairwell		2,000	2,000
Total		4,000	89,000

Advisory Messages

	Proposed Building Design	Budget Building	Difference (Proposed - Budget)
Percent of hours sytem load out of throttling range	0.0%	1.0%	1.0%
Percent of hours plant load not met	0.0%	0.0%	0.0%
Number of warnings	0	0	0
Number of errors	0	0	0
Number of defaults overridden	1	4	3
Description of differences between the budget building and proposed design not documented on other forms:			
<input type="checkbox"/> Not Applicable <input checked="" type="checkbox"/> Attached			

Compliance Result

The design detailed in the above referenced plans complies with the mandatory requirements of ASHRAE 90.1 1999 and the design energy cost does not exceed the Energy Cost Budget. Therefore, this design DOES COMPLY with the ASHRAE 90.1 1999 ECB Compliance Methodology.

Individual certifying authenticity of this data provided in this analysis:

Signature: 	Title: Mechanical Engineer
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Energy Summary by End Use

End Use	Regulated?	Energy Type	Proposed Building		Budget Building		Optimized Energy Performance [%]
			Energy	Peak	Energy	Peak	
			[10 ³ Btu]	[10 ³ Btu/h]	[10 ³ Btu]	[10 ³ Btu/h]	
Lighting - Conditioned	x	Electricity	524,326	200	1,194,349	375	44%
Lighting - Unconditioned							
Space Heating	x	Natural Gas	641,200	1,345	646,400	1,498	99%
Space Cooling	x	Chilled Water	2,150,000	2,763	2,576,000	3,146	83%
Pumps	x	Electricity	26,690	26	47,458	35	56%
Heat Rejection							
Fans - Interior Ventilation	x	Electricity	92,820	45	162,899	87	57%
Fans - Interior Exhaust							
Fans - Parking Garage							
Service Water Heating	x	Natural Gas	608,100	51	608,100	51	100%
Office Equipment		Electricity	418,239	127	418,239	127	100%
Exterior Lighting		Electricity	73,420	11	73,420	11	100%
TOTAL BUILDING CONSUMPTION			4,534,795		5,726,865.2		79%
TOTAL REGULATED BUILDING CONSUMPTION			4,043,135		5,235,205		

Note: Enerav Consumption is listed in units of site enerav
 10³ Btu = kWh x 3.413 10³ Btu = therms / 100

Energy and Cost Summary by Fuel Type

Type	DEC Use [10 ³ Btu]	DEC Cost [\$]	ECB Use [10 ³ Btu]	ECB Cost [\$]	DEC / ECB Energy % Cost %	
NONRENEWABLE (REGULATED + UNREGULATED)						
Electricity (Total)	1,135,495	\$ 39,347	1,896,365	\$ 65,342	60%	60%
Natural Gas (Total)	1,249,300	\$ 7,664	1,254,500	\$ 7,694	100%	100%
Chilled Water (Total)	2,150,000	\$ 20,964	2,576,000	\$ 25,118	83%	83%
Total Nonrenewable (Regulated + Unregulated)	4,534,795	\$67,975	5,726,865	\$98,154	79%	69%
NONRENEWABLE (REGULATED ONLY)						
Type	DEC' Use [10 ³ Btu]	DEC' Cost [\$]	ECB' Use [10 ³ Btu]	ECB' Cost [\$]	DEC' / ECB' Energy % Cost %	
Electricity (Total)	643,835	\$ 22,310	1,404,705	\$ 48,401	46%	46%
Natural Gas (Total)	1,249,300	\$ 7,664	1,254,500	\$ 7,694	100%	100%
Chilled Water (Total)	2,150,000	\$ 20,964	2,576,000	\$ 25,118	83%	83%
Total Nonrenewable (Regulated Only)	4,043,135	\$50,938	5,235,205	\$81,213	77%	63%
RENEWABLE						
Type	DEC'' Use [10 ³ Btu]	DEC'' Cost [\$]			DEC' / ECB' Energy % Cost %	
Renewable Photovoltaics (REC)	(153,841)	\$ (5,331)			-	-
Total including Renewable	3,889,294	\$ 45,607	5,235,205	\$ 81,213	74%	56%
Percent Savings = (ECB' \$ -DEC'' \$)/ECB' \$ =					44%	
Percent Renewable = REC \$/DEC' \$ =					10%	