BEREA COLLEGE DEEP GREEN STUDENT RESIDENCE: Performance over Time

The Berea College Deep Green Student Residence

Daniel F. Hellmuth, AIA LEED AP, NCARB - Hellmuth + Bicknese Architects
Joan Pauly, Sustainability Coordinator - Berea College Office of Sustainability

TYSON LIVING LEARNING CENTER (LBC CERTIFIED)
Cost: 1.5 Million **Sf:** 3,000 Learning Center/ 1,100

BEREA COLLEGE: DEEP GREEN STUDENT RESIDENCE
(LEED PLATINUM + LBC PETAL CERTIFIED – MATERIALS)
Cost: 13 Million **Sf:** 11,500

THE COLLEGE SCHOOL: JAN PHILLIPS LEARNING CENTER (LBC REGISTERED)
Budget: 1.6 Million **Sf:** 3,300 Learning Center / 1,500 Pavilion

KNOX COLLEGE: GREEN OAKS FIELD STATION
Cost: TBD **Sf:** TBD

TYSON RESEARCH CENTER: Living Community Challenge
Cost: TBD **Size:** 2,000 acres

BUTLER UNIVERSITY LIVING BUILDING (BULB)
Cost: TBD **Sf:** TBD

MOVING FORWARD: Net Zero Energy Affordable Housing
Cost: 9 Million **Sf:** 60,500

PROJECT GOALS + THE BEREA STORY

"Learning by Living"

Berea College envisioned a Deep Green Student Residence that would be attractive to all students on campus, impart environmental consciousness and a deeper understanding of Sustainable Living through the experience of living in the building, both directly and indirectly.

Deep Green, is the highest rated LEED residence hall in the World. With an added focus on sustainability, students who choose to live in Deep Green can expect to experience Deep Green's signature Spotlight Speaker series which brings a variety of speakers and activities to the hall each semester (generally focused on sustainability). This $13 million dollar residence hall was completed in 2013 and has since changed the university housing standard by changing policy within LEED, Living Building Challenge, and how our students live within a residence hall. Using state of the art sustainable processes and technologies, Deep Green has earned LEED Platinum + LBC Petal Certification, and has won several awards including the 2014 Best Use of Green & Sustainable Design/Construction by On Campus Student Housing Business, the 2014 Project of the Year by Associated General Contractors of Kentucky, the 2014 Merit Award and Green Project, by ENR Midwest, and other regional sustainability awards and mentions.

A. THE IMPORTANCE OF ESTABLISHING GOALS

1. Environmental Goals and Options
2. Project Certification Options
3. Role of the Building as an Educational Tool
4. Early Framework

B. CONCEPTUAL DESIGN

1. Benchmarking
    1. ASHRAE 90.1
    2. EUI Targets
    3. Design for Energy Efficiency
        - Building Orientation + Massing
        - Solar Access
        - Shading Analysis
    4. PV Layout
    5. Building Envelope Options
    6. HVAC + Lighting Options
    7. Initial Architectural Modeling
    8. Concept Designs

C. ENERGY PERFORMANCE MODELING

1. Predictive vrs. Standard Modeling
    - Establishing Factors
2. Academic vrs. Design Engineering
3. Modeling Process
4. Establishing the ACH!
5. Testing

D. DESIGN DEVELOPMENT

1. Final EUI
2. Final Selections based on Modeling
    - Final Building Envelope
    - Lighting
    - HVAC
3. PV Layout

Goal Setting during the Conceptual Design Phase

Importance of Conceptual Design Phase to explore options, set budgets & goals and establish consensus

2 Full Day Charrettes with Administration, Staff, Students and Design Team.

Explore Unique Aspects of Berea College

- Student Labor Program
- Student Crafts
- History of Student Construction
- 8,000 acre Berea College Forest
- Art Department

LEED Platinum – Living Building Challenge Stretch Goal

Integrate Pedagogical Opportunities into the Design, Construction Process and Daily Living

"Learning by Living"

Berea College

101 Chestnut Street Berea, KY
LEED NC 2009 Project Checklist

Date: 02.10.2012

Score 84

Certified 40-49 points **Silver** 50-59 points **Gold** 60-79 points **Platinum** 80 points and above **Possible Points** 110

Y	?	N	Sustainable Sites	Possible Points	26
Y			Prereq 1	Construction Activity Pollution Prevention	0
1			Credit 1	Site Selection	1
5			Credit 2	Development Density & Community Connectivity	5
		1	Credit 3	Brownfield Redevelopment	1
		6	Credit 4.1	Alternative Transportation, Public Transportation Access	6
1			Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1
3			Credit 4.3	Alternative Transportation, Low-Emitting and Fuel-Efficient Vehicles	3
2			Credit 4.4	Alternative Transportation, Parking Capacity	2
		1	Credit 5.1	Site Development, Protect or Restore Habitat	1
1			Credit 5.2	Site Development, Maximize Open Space	1
1			Credit 6.1	Stormwater Design, Quantity Control	1
1			Credit 6.2	Stormwater Design, Quality Control	1
1			Credit 7.1	Heat Island Effect, Non-Roof	1
1			Credit 7.2	Heat Island Effect, Roof	1
1			Credit 8	Light Pollution Reduction	1

Y	?	N	Water Efficiency	Possible Points	10
Y			Prereq 1	Water Use Reduction	0
2			Credit 1.1	Water Efficient Landscaping, Reduce by 50%	2
2			Credit 1.2	Water Efficient Landscaping, No Potable Water Use	2
	2		Credit 2	Innovative Wastewater Technologies	2
2			Credit 3.1	Water Use Reduction, 30% Reduction	2
1			Credit 3.2	Water Use Reduction, 35% Reduction	1
1			Credit 3.3	Water Use Reduction, 40% Reduction	1

Y	?	N	Energy & Atmosphere	Possible Points	35
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	0
Y			Prereq 2	Minimum Energy Performance (ASHRAE 90.1-2007)	0
Y			Prereq 3	Fundamental Refrigerant Management	0
1			Credit 1.1	Optimize Energy Performance, 12% New / 8% Existing	1
1			Credit 1.2	Optimize Energy Performance, 14% New / 10% Existing	1
1			Credit 1.3	Optimize Energy Performance, 16% New / 12% Existing	1
1			Credit 1.4	Optimize Energy Performance, 18% New / 14% Existing	1
1			Credit 1.5	Optimize Energy Performance, 20% New / 16% Existing	1
1			Credit 1.6	Optimize Energy Performance, 22% New / 18% Existing*	1
1			Credit 1.7	Optimize Energy Performance, 24% New / 20% Existing*	1
1			Credit 1.8	Optimize Energy Performance, 26% New / 22% Existing	1
1			Credit 1.9	Optimize Energy Performance, 28% New / 24% Existing	1
1			Credit 1.10	Optimize Energy Performance, 30% New / 26% Existing	1
1			Credit 1.11	Optimize Energy Performance, 32% New / 28% Existing	1
1			Credit 1.12	Optimize Energy Performance, 34% New / 30% Existing	1
	7		Credit 1.13-1.19	Optimize Energy Performance, 36-48% New / 32-44% Existing	7
1			Credit 2.1	On-Site Renewable Energy, 1%	1
1			Credit 2.2	On-Site Renewable Energy, 3%	1
1			Credit 2.3	On-Site Renewable Energy, 5%	1
1			Credit 2.4	On-Site Renewable Energy, 7%	1
1			Credit 2.5	On-Site Renewable Energy, 9%	1
1			Credit 2.6	On-Site Renewable Energy, 11%	1
1			Credit 2.7	On-Site Renewable Energy, 13%	1
2			Credit 3	Enhanced Commissioning	2
2			Credit 4	Enhanced Refrigerant Management	2
3			Credit 5	Measurement & Verification	3
		2	Credit 6	Green Power	2

* in increments of 3.5%

52	9	10		SUBTOTAL	52

Y	?	N	Materials & Resources	Possible Points	14
Y			Prereq 1	Storage & Collection of Recyclables	0
		1	Credit 1.1	Building Reuse, Maintain 55% of Existing Walls, Floors & Roof	1
		1	Credit 1.1	Building Reuse, Maintain 75% of Existing Walls, Floors & Roof	1
		1	Credit 1.1	Building Reuse, Maintain 95% of Existing Walls, Floors & Roof	1
		1	Credit 1.2	Building Reuse, Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	Construction Waste Management, Divert 50% from Disposal	1
1			Credit 2.2	Construction Waste Management, Divert 75% from Disposal	1
		1	Credit 3.1	Materials Reuse, Specify 5%	1
		1	Credit 3.2	Materials Reuse, Specify 10%	1
1			Credit 4.1	Recycled Content, 10% (post-consumer + ½ pre-consumer)	1
1			Credit 4.2	Recycled Content, 20% (post-consumer + ½ pre-consumer)	1
1			Credit 5.1	Local/Regional Materials, 10% Extracted, Processed & Manufactured Regionally	1
1			Credit 5.2	Local/Regional Materials, 20% Extracted, Processed & Manufactured Regionally	1
	1		Credit 6	Rapidly Renewable Materials	1
1			Credit 7	Certified Wood	1

Y	?	N	Indoor Environmental Quality	Possible Points	15
Y			Prereq 1	Minimum IAQ Performance	0
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	0
1			Credit 1	Outdoor Air Delivery Monitoring (ASHRAE 62.1-2007)	1
1			Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan, During Construction	1
1			Credit 3.2	Construction IAQ Management Plan, Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials, Adhesives & Sealants	1
1			Credit 4.2	Low-Emitting Materials, Paints & Coatings	1
1			Credit 4.3	Low-Emitting Materials, Flooring Systems	1
1			Credit 4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products	1
1			Credit 5	Indoor Chemical & Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems, Lighting	1
1			Credit 6.2	Controllability of Systems, Thermal Comfort	1
1			Credit 7.1	Thermal Comfort, Design	1
1			Credit 7.2	Thermal Comfort, Verification	1
1			Credit 8.1	Daylight & Views, Daylight 75% of Spaces	1
1			Credit 8.2	Daylight & Views, Views for 90% of Spaces	1

Y	?	N	Innovation & Design Process	Possible Points	6
1			Credit 1.1	Innovation in Design: Educational Signage	1
1			Credit 1.2	Innovation in Design: Exemplary Construction Waste Management	1
1			Credit 1.3	Innovation in Design: Green Cleaning	1
1			Credit 1.4	Innovation in Design: Low-Mercury Lighting	1
1			Credit 1.5	Innovation in Design: Extensive Recycling Program	1
1			Credit 2	LEED™ Accredited Professional	1

Y	?	N	Regional Priority	Possible Points	4
1			Credit 1.1	Regional Priority (EAc1: 30% New, 26% Existing)	1
1			Credit 1.2	Regional Priority (EAc2: Renewable Energy : 1%)	1
1			Credit 1.3	Regional Priority (MRc2: Construction Waste Management: 50%)	1
1			Credit 1.4	Regional Priority (WEc3 Water Reduction: 40%)	1

32	1	6		SUBTOTAL	84
84				TOTAL	84
TOTAL POINTS					

LEED GOAL SETTING

Y	?	N				
0	0	0		**Energy and Atmosphere**	Possible Points:	**35**
Y			C	Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			d	Prereq 2	Minimum Energy Performance	
Y			d	Prereq 3	Fundamental Refrigerant Management	
			d	Credit 1	Optimize Energy Performance	1 to 19
					Improve by 12%-48% for New Buildings or 8%-44% for Existing Buildings	1
			d	Credit 2	On-Site Renewable Energy	1 to 7
					1%, 3%, 5%, 7%, 9%, 11%, 13% Renewable Energy	
			C	Credit 3	Enhanced Commissioning	2
			d	Credit 4	Enhanced Refrigerant Management	2
			C	Credit 5	Measurement and Verification	3
			C	Credit 6	Green Power	2

LEED: Energy Efficiency

LIVING BUILDING CHALLENGE

THE METAPHOR OF THE FLOWER

ROOTED IN PLACE AND YET:

Harvests all energy + water

Is adapted to climate and site

Operates pollution free

Is comprised of integrated systems

Is beautiful

ENERGY

RELYING ONLY ON CURRENT SOLAR INCOME

PETAL INTENT

The intent of the Energy Petal is to signal a new age of design, wherein the built environment relies solely on renewable forms of energy and operates year round in a safe, pollution-free manner. In addition, it aims to prioritize reductions and optimization before technological solutions are applied to eliminate wasteful spending—of energy, resources, and dollars. The majority of energy generated today is from highly polluting and often politically destabilizing sources including coal, gas, oil and nuclear power. Large-scale hydro, while inherently cleaner, results in widespread damage to ecosystems. Burning wood, trash or pellets releases particulates and carbon dioxide (CO_2) into the atmosphere and often strains local supplies of sustainably harvested biomass while robbing the soil of much-needed nutrient recycling. The effects of these energy sources on regional and planetary health are becoming increasingly evident through climate change, the most worrisome major global trend attributed to human activity.

IDEAL CONDITIONS AND CURRENT LIMITATIONS

The Living Building Challenge envisions a safe, reliable and decentralized power grid, powered entirely by renewable energy, supplied to incredibly efficient buildings and infrastructure without the negative externalities associated with combustion or fission.

Although there has been considerable progress made to advance renewable energy technologies, there is still a need for a greater efficiency from these systems and for new, cleaner ways to store the energy they generate. These, together with the current cost of the systems available, are the major limitations to reaching our goals.

SCALE JUMPING PERMITTED FOR **NET POSITIVE ENERGY** (IMPERATIVE 06)

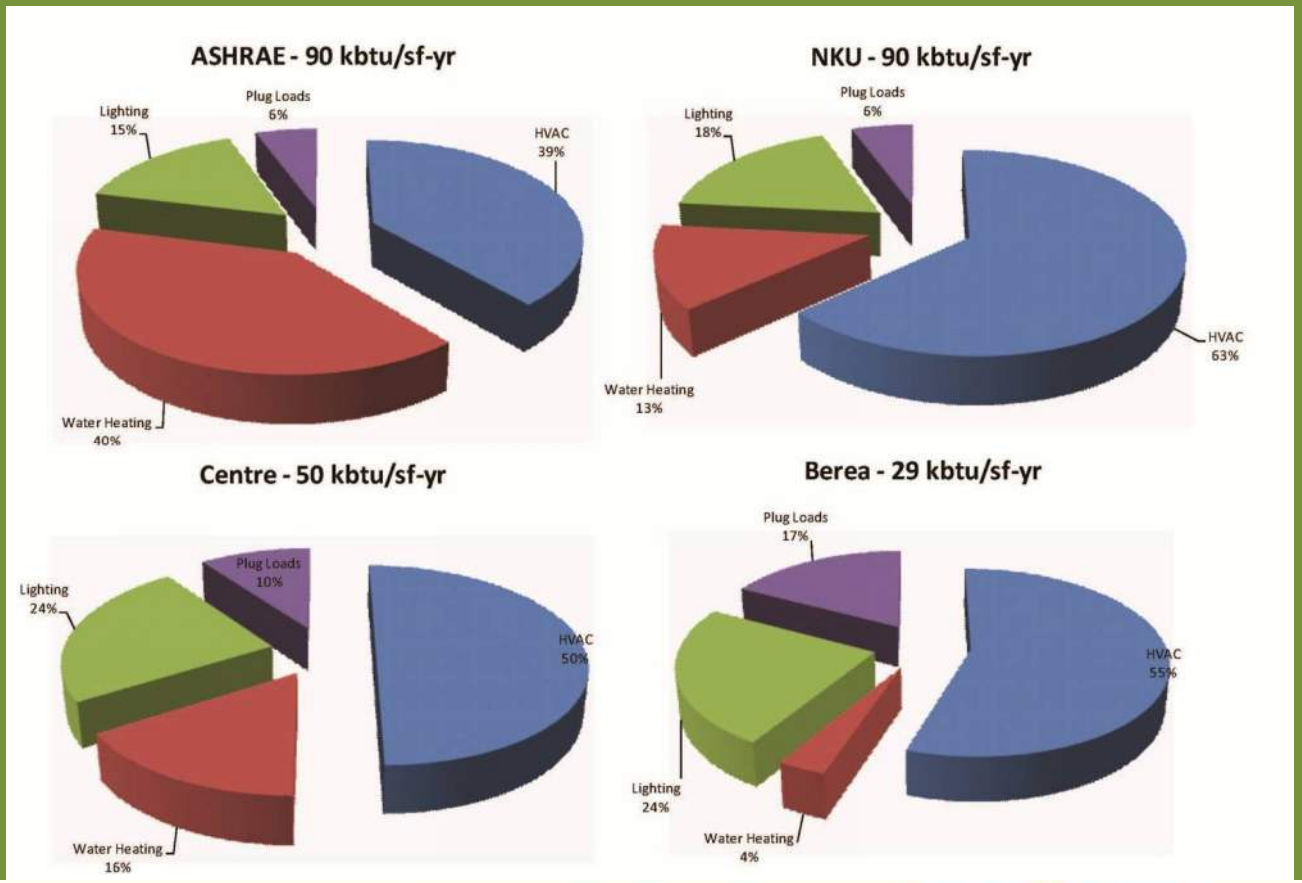
NETZERO ENERGY BUILDING CERTIFICATION

Table 2 2003 Commercial Sector Floor Area and EUI Percentiles

Building Use	Calculated, Weighted Number of Buildings, Hundreds	Calculated, Weighted Floor Area, 10^9 ft^2	Actual Number of Buildings, *N*	Calculated, Weighted Energy Use Index (EUI) Values Site Energy, kBtu/yr per gross square foot — Percentiles 10th	25th	50th	75th	90th	Mean
Administrative/professional office	442	6.63	555	28.1	41	62	93	138	75
Bank/other financial	104	1.10	75	55.7	67	87	117	184	106
Clinic/other outpatient health	66	0.75	100	28.7	41	66	97	175	84
College/university	34	1.42	88	14.1	67	108	178	215	122
Convenience store	57	0.16	28	68.6	156	232	352	415	274
Convenience store with gas station	72	0.28	32	82.2	135	211	278	409	225
Distribution/shipping center	155	5.25	231	8.7	17	33	54	91	45
Dormitory/fraternity/sorority	16	0.51	37	36.3	65	74	100	154	90
Elementary/middle school	177	4.75	331	21.1	35	54	93	127	76
Entertainment/culture	27	0.50	50	1.7	29	46	134	418	95
Fast food	78	0.26	95	176.3	268	418	816	933	534
Fire station/police station	53	0.38	47	6.9	24	82	112	137	78
Government office	84	1.55	150	31.5	52	77	103	149	85
Grocery store/food market	86	0.71	117	98.1	138	185	239	437	213
High school	68	2.52	126	19.8	44	65	99	130	75
Hospital/inpatient health	8	1.90	217	108.1	169	196	279	355	227
Hotel	20	1.90	86	39.7	51	73	116	183	95
Laboratory	9	0.65	43	98.0	165	270	505	925	362
Library	20	0.56	36	35.0	67	92	121	197	104
Medical office (diagnostic)	54	0.50	58	14.1	25	44	100	137	60
Medical office (nondiagnostic)	37	0.22	33	25.7	40	52	66	109	59
Mixed-use office	84	2.30	172	20.0	38	71	106	158	88
Motel or inn	70	1.05	109	23.9	37	67	102	197	87

Energy Use Intensity: Goal Setting

EUI is expressed as energy per square foot per year. It's calculated by dividing the total energy consumed by the building in one year (measured in kBtu) by the total gross floor area of the building.
EUI varies by building type and climate zone but can be used as a very valuable comparative and targeting metric.



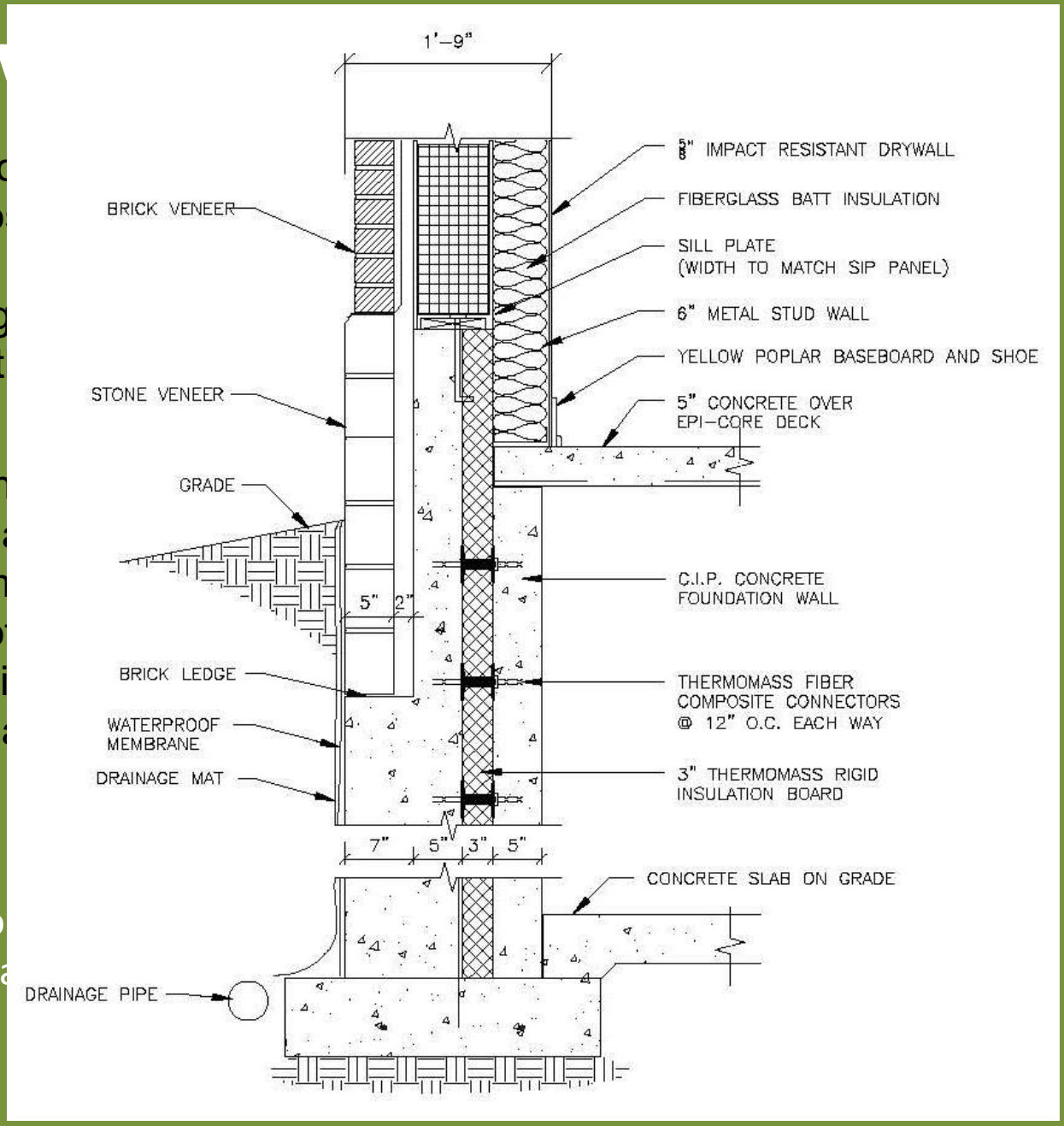
Building Env

Reduction of energy loss and
for orientation is the next mo
energy costs, and in helping
a High-Performance Building
reducing infiltration through t
heat gain.

SIP panels have one of the h
infiltration rates. The combina
mass foundation wall system
insulation from footing to roo
are used. With careful attenti
caulking of SIP panel joints, a

Strategies include:

- Continuous Insulation
- Comprehensive Air Infiltratio
- High Performance Windows a
- Rainscreen
- Exterior Solar Shading



Daylighting and Natural Ventilation

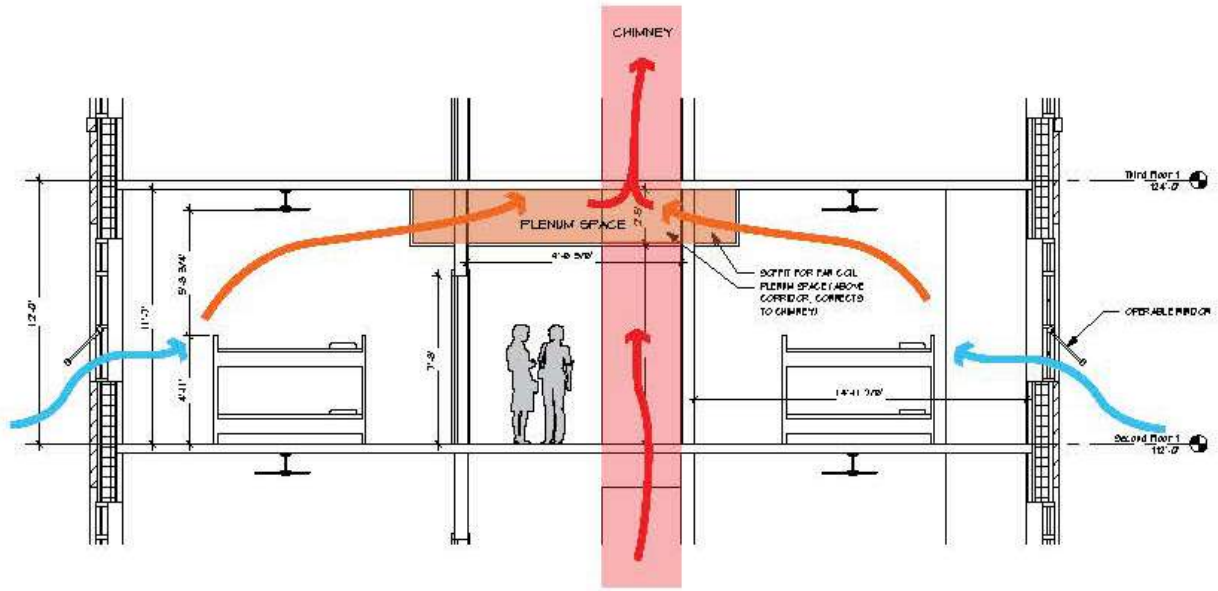
Recommendations for Natural and Assisted Ventilation

8.04.2011

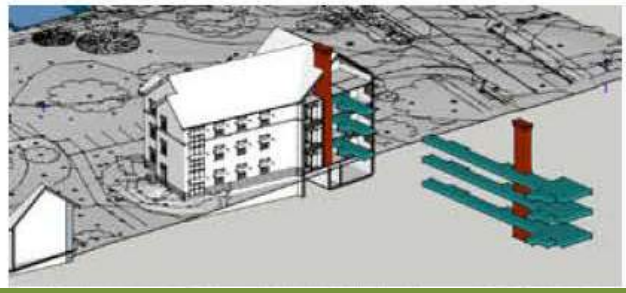
Big Ass Fans - Isis
Typ. Student Lounge
6' wide
10 Blades

Third Floor Reflected Ceiling Plan Layout

Natural + Assisted Ventilation:



Berea College New Student Residence
Natural Ventilation - Building Section



ENERGY CONSUMPTION SUMMARY

By CMTA

	Elect Cons. (kWh)	Gas Cons. (kBtu)	% of Total Building Energy	Total Building Energy (kBtu/yr)	Total Source Energy* (kBtu/yr)
Alternative 3 Central Plant connected 4 pipe fan coil system w/ DOAS					
Primary heating					
Primary heating		772,951	40.3 %	772,951	813,632
Other Htg Accessories	6,442		1.1 %	21,985	65,962
Heating Subtotal	**6,442**	**772,951**	**41.4 %**	**794,936**	**879,594**
Primary cooling					
Cooling Compressor	50,918		9.1 %	173,784	521,405
Tower/Cond Fans			0.0 %	0	0
Condenser Pump			0.0 %	0	0
Other Clg Accessories	6,632		1.2 %	22,635	67,912
Cooling Subtotal....	**57,550**		**10.2 %**	**196,419**	**589,317**
Auxiliary					
Supply Fans	82,313		14.6 %	280,933	842,883
Pumps			0.0 %	0	0
Stand-alone Base Utilities			0.0 %	0	0
Aux Subtotal....	82,313		14.6 %	280,933	842,883
Lighting					
Lighting	109,891		19.5 %	375,057	1,125,283
Receptacle					
Receptacles	79,956		14.2 %	272,890	818,751
Cogeneration					
Cogeneration			0.0 %	0	0
Totals					
Totals**	**336,151**	**772,951**	**100.0 %**	**1,920,235**	**4,255,829**

HVAC total = 1272288 kBtu/yr

1272288 kBtu/yr / 38890 ft² = 32.7 kBtu/ft²/yr.

* Note: Resource Utilization factors are included in the Total Source Energy value.
** Note: This report can display a maximum of 7 utilities. If additional utilities are used, they will be included in the total.

Imperative 7:

Net Zero Energy

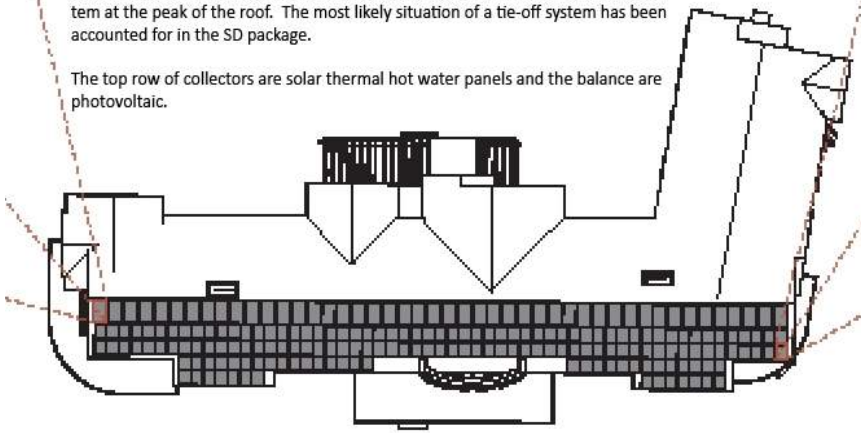
The cost of PV has dropped from $8/watt to $3/watt in just 5 years.

8.04.2011

The large, south facing roof area of the student residence hall makes an idea mounting "platform" for solar collectors (both photovoltaic and thermal). It is sloped close to latitude for Berea, KY and is high enough to avoid shading by trees on the south side of the building although some will have to be removed.

The collectors clip onto the standing seam metal roof with an "S-5" clamp making them easy to install and remove if necessary. The state building code officials are debating on whether a guard would be needed at the bottom or a tie-off rod system at the peak of the roof. The most likely situation of a tie-off system has been accounted for in the SD package.

The top row of collectors are solar thermal hot water panels and the balance are photovoltaic.



Photovoltaic Panel Detail

S-5 PV Roof Connection Detail

EUI TARGET
30kBTU/SF/year
ALL LEED ENERGY CREDITS
(16% renewable)
NET ZERO ONLY A MATTER OF $$
(and some logistics)

SUNPOWER

E18 / 305 SOLAR PANEL

EXCEPTIONAL EFFICIENCY AND PERFORMANCE

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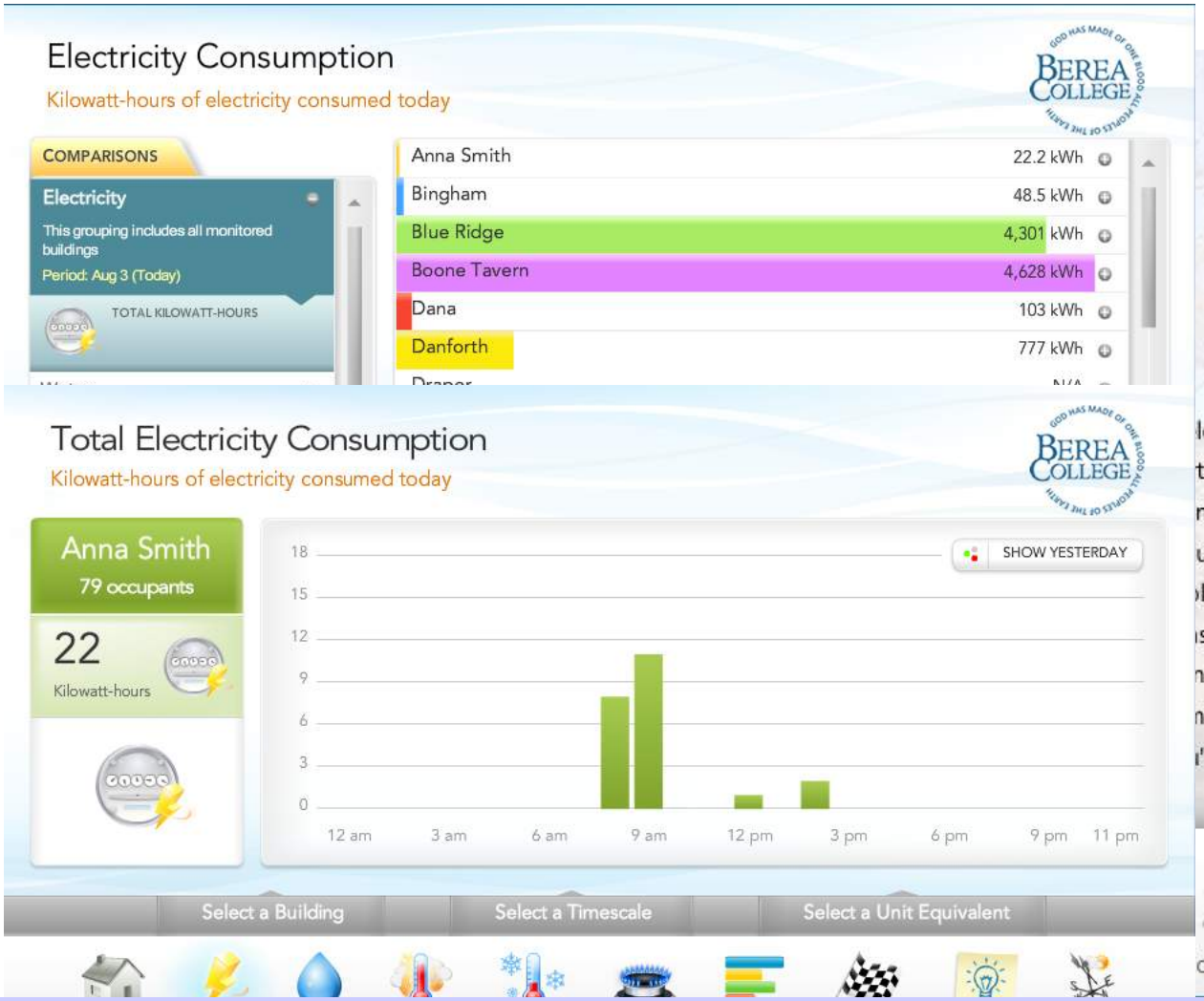
Proven materials, tempered front glass, and a sturdy anodized frame allow panel to operate reliably in multiple mounting configurations.

and performance. Utilizing 96 back-contact solar cells, the SunPower 305 delivers a total panel conversion efficiency of 18.7%. The panel's reduced voltage-temperature coefficient and exceptional low-light performance attributes provide outstanding energy delivery per peak power watt.

BUILDING DASHBOARD



FACILITATES AWARENESS AND CAN INCITE COMPETITION: DORM WARS

SITE + BUILDING AS TEACHING TOOL

Research

The data collection points built into the site and building provide the opportunity for performance research and analysis of systems which can provide the very specific lessons on how the site and building interacts with the environment.

Curriculum

At this level, the actual performance of systems and materials can be studied using the site and building as a "living" case study resulting in a deeper understanding of sustainability issues.

Outreach + Interaction

This more active educational mode creates focused attention on systems and components and can utilize students living in the residence as ambassadors to other prospective students and visitors.

Signage (Interpretive and Dynamic)

Although requiring more attention, this educational mode begins to look "under the hood" and provide feedback and interpretation at a very straight-forward level and can highlight systems not immediately visible.

Visually Sustainable Features

This provides the broadest educational opportunity on a very low-key level creating daily interaction and surface understanding of systems and components.

Imperative 20:

Inspiration + Education

OPPORTUNITY: TO TELL THE BEREA COLLEGE STORY

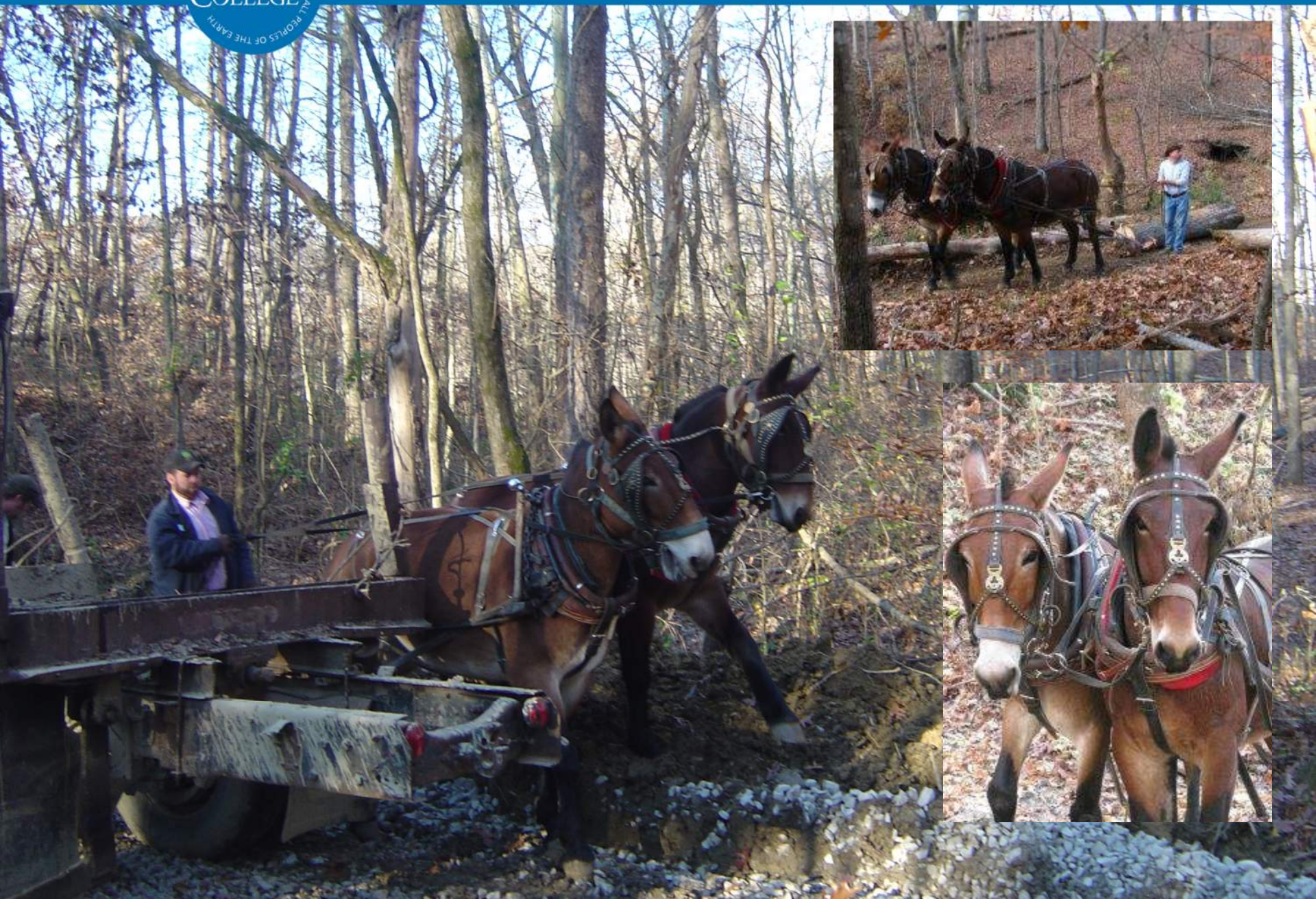
Learning by Living: Berea College Sustainable Dormitory

Berea College envisioned a Deep Green Student Residence that would be attractive to all students on campus, impart environmental consciousness and a deeper understanding of Sustainable Living through the experience of living in the building, both directly and indirectly.

THE BEREA COLLEGE FOREST

Materials - FSC

SKIDDING LOGS WITH A MULE TEAM



Timber Production

ON-SITE MILLING

INTERIOR WOODWORK

Student Labor Program

THIRD FLOOR STUDENT LOUNGE

FURNITURE

10 STUDENTS ALLOCATED FROM LABOR PROGRAM TO BUILD THE FURNITURE OVER A 1 –YEAR PERIOD.

1 STAFF CRAFTSMAN HIRED FOR 1 YEAR TO ORGANIZE + ASSIST

DEEP GREEN FURNITURE TEAM

MEETING SCHEDULE

FURNITURE

Student Labor Program

HAPPY ENDING!