Why be green?

What should Purdue be doing?

PURDUE’S FIRST LEED BUILDINGS

LEED COST SAVINGS
ROGER B. GATEWOOD ADDITION
-- Larry Fusaro, U. Architect

$26K – Annual Energy Cost Savings
$185K – Avoided Utility Plant Infrastructure Cost
$493K – Smaller Building Mechanical, Electrical, Plumbing Systems

Additional Benefits:
Lower Operating costs with commissioned, measured, verified energy systems
Increased productivity of occupants from improved indoor environment
FUTURE PURDUE LEED/GREEN GLOBES BUILDINGS

LEED
- France A. Cordova Recreational Sports Center
- Ray W. Herrick Laboratories
- Center for Student Excellence and Leadership
- Vawter Field Housing

GREEN GLOBES
- Multidisciplinary Research Center (Bindley Bioscience Center)
- Drug Discovery
- Lyles Porter Health and Human Sciences Research Facility

SUSTAINABILITY

“To call an activity ‘sustainable’ means that it can be continued or repeated for the foreseeable future” - Townsend, Begon, Harper text

Also, supportable, ecologically tenable, without degradation of:
- carrying capacity
- ecosystem services
- biodiversity
- quality of life
- ecosystem health (?)

An activity compatible with a stable, healthy (“natural”) ecosystem that can be done for a long time without too much long-term harm

Need definitions of LONG time and HARM
Certification systems like LEED (Leadership in Energy & Environmental Design) promote long-term life-cycle thinking

Can human economies be sustainable? Diamond’s Collapse:
- Can we beat the rap that overreach is our signature?

Las Vegas: runs on coal and water from Navajo aquifer

Forest Stewardship Council and certifying sustainable forestry

Principle 6: Environmental Impact. Forest management shall conserve biological diversity and its associated values, water resources, soils, and unique and fragile ecosystems and landscapes, and, by so doing, sustain the ecological functions and the integrity of the forest.
The Reserve is the Living Laboratory of the Department of Biological Sciences, as envisioned by founder Alton Lindsey in 1949, integrating field research, teaching, and outreach in ecology.

**Ross Reserve Quick Facts**
- 92 acres of forest forest on the Wabash River
- Alton A. Lindsey Field Laboratory for classes and research
- 60+-year database of forest composition in a surveyed grid
- 1,000+ species of terrestrial plants
- 400+ species of terrestrial animals
- 35+ undergraduate researchers and 15+ class projects
- 100+ graduate students experience the Reserve each year during field trips
- 30 Ph.D. dissertations, 120 scientific publications, and 64+ Masters & Honors theses
- 14 faculty use the Reserve for teaching, research, and outreach
- Outreach to K-12 schools: 108 students and teachers annually
- A graduate "ecologist in residence" facilitates outreach, teaching and outreach

The Reserve is a center for community outreach promoting scientific literacy and understanding of the natural world.

Website: ecology.bsu.indiana.edu/ross-reserve
Contact: rlbms@bsu.edu

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**Current Research Highlights**

*Do birds see the world differently?*
Every bird has a different visual system depending on the habitat they occupy; their food preferences, and their natural predators. Research by Dr. Emily Parmiter-Jones and colleagues is developing an understanding of how this affects the colors and shape of objects that attract (food) or are less attractive (predator) to birds.

*How will climate change affect spring wildflowers in Indiana woodlands?*
The flowers' ability to sprout and grow in response to rainfall and temperature conditions is critical to their survival. Recent research by Dr. Nancy Breit and colleagues is examining the effects of temperature and climate change on wildflower distribution and abundance. Their work is critical to developing a comprehensive understanding of the ecological impacts of climate change.

*Has hearing in songbirds evolved with song?*
Recent research by Dr. Jennifer Lee and colleagues is investigating the evolution of songbird hearing. Their work has revealed that songbirds have evolved unique hearing mechanisms that allow them to perceive sounds that are outside the range of human hearing. This research is providing new insights into the evolution of hearing in songbirds.

*How do maintenance requirements compare?*
Recent work by Dr. Richard Howard and colleagues is comparing the maintenance requirements of different songbird species. Their research is revealing that songbird species have evolved different maintenance requirements, which is helping to explain their ecological success.

*Do invasive plants inhibit native species?*
Recent research by Dr. Richard Howard and colleagues is investigating the impact of invasive plants on native species. Their work is revealing that invasive plants are altering the ecological landscape, which is having a significant impact on the distribution and abundance of native species.

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Ross Reserve, 1950

*Ross Reserve on the north shore of the Wabash, flanked by the Ross Hills Country Park*
Flowering Dogwood: long-term population dynamics

Education
Undergraduate Research
• Class Projects
• Independent Studies
• Honor's thesis projects
• Research assistantships
• Climate-change experiments: will pollinator-plant relationships decouple?

Conservation Biology class

Burnett Creek Elementary class
Infrastructure started with surveyed grid, then trail system. Facilitating long-term study of forest dynamics.

**Lindsey Lab, built 1999, mainly a classroom**

**Principal Functions of the Ross Reserve Building Project:**

To provide a classroom that communicates principles of sustainable building through energy and materials efficiency and low-impact functioning.

To support research and teaching activities at the Reserve by housing a live-in graduate “ecologist in residence”

To provide a model for the community of affordable sustainability and an opportunity for interdisciplinary collaboration

A “living building” that emulates the sustainability of living systems, with interpretive content, functioning as a teaching tool and a source of inspiration ... Serving as a launching pad for exploration of the forest – a vehicle of discovery in a “living laboratory” and an instrument for change in construction norms.

**Central ecological concepts to be conveyed:**

1. Structural efficiencies of biological systems from bone to forest
2. Efficiency of energy capture, flow, and storage
3. Information gathering, processing, and retrieval
4. Efficiency of water use and return
5. Nutrient cycles and human perturbations
6. Self-regulation of biological systems (e.g., thermoregulation)
7. Ecological resilience (stability and recovery of communities and ecosystems)
8. Impacts of organisms on others in the natural community (competition/cooperation)
9. Long-term dynamics of ecosystems

**Corresponding biomimicry foci:**

1. Strength/weight ratios and the engineering properties of materials, joints and frames; conservation of materials and embodied energy
2. Trees and buildings as energy collectors, conductors and storage devices
3. Buildings as information capture and storage devices; peripheral and central nervous systems; bringing nature in – making building permeable to sights & sounds
4. Reusing wastewater; exploiting the physical and chemical properties of water
5. Waste recycling: not just flushing into environment; creating micro-environments without damaging ecosystem chemistry; regenerative for soils
6. Parallels between organ systems and regulatory systems in building (e.g., chemical and thermal regulation); feedbacks between internal state and external function
7. Optimum complexity: complex structure stabilized by complementarity of function
8. “Community of interest” in the building process – an educational program; modulation of impact on ecosystem by feedbacks from environment
9. Long-term calculations of value; life-cycle analysis of impact

**Figure 7.1**—With direct gain passive solar designs, south-facing windows and skylights collect sunlight, and the heat is stored in high-mass materials in the living spaces.
Many strategies for energy efficiency are ancient.

Mandan earthen lodges

Demonstrate Feasibility of Energy Efficiency

Buckminster Fuller: doing more with less

Geodesic dome in Montreal 1967: Dymaxion house

Not impressive? deleting corner studs, headers

INhome Solar Decathlon team from Purdue

2nd place of 19 international entries

Judged for architecture, engineering, energy balance & affordability

Progress:

Architect-led planning: public discussion and planning workshop; refinement of “green” objectives

Solidifying team: five colleges and administration

(U. Architect, Sustainability, Deans, Provost, VPR)

Seminar gathering to pool expertise and ideas

Purdue experiences (e.g. solar decathlon; LEED)

How create a model of “sustainability”

How to apply to Ross Reserve project

Teaching/training (classes); research/experimentation

“Benchmarking”: learning from other places

Tyson Living Learning Center, Phipps Conservatory …

Certification possibilities: Living Building Challenge …

Financing and projection possibilities (can hit $250/ft²) (alumni)

Message design: optimizing the educational mission.

Long-term view: not just a building, but a program

Spring Courses: Biol595: Ecological Principles in Building

College of College of College of College of College of College of Science Technology Engineering Liberal Agriculture Science

Biol, Sci. Bldg, Con, Bldg, Arch, Biol, Sci. Triang., Earth, Hortic, Horticulture,

EAS Man, Tech; Mech, Eng, Eng, Environ, Agronomy, Landscape,

Technology Technology Materials, Design, Science Technology Technology

Kuhn Hutzel Kuhn Anderson Kuhn Karava, Schulenberg, H. H. VanZee

Emery Anderson Schulenberg. R, E. H. Nies, Insel, FNR

Kabenoil Hultzel Schulenberg H. Nies, Hua

Lucas Holt, Alter Holtzel Nies, Hua

W Ater Crawford Cury Nies, Hua

Fernandez Crawford Cury Nies, Hua

Howard Cury Cury Nies, Hua

Hutzel, Alter Cury Cury Nies, Hua

Fusaro, Collier Cury Cury Nies, Hua

Callies Cury Cury Nies, Hua

Fusaro, Collier Cury Cury Nies, Hua

Lee Cury Cury Nies, Hua

Dahl Cury Cury Nies, Hua

Turco Cury Cury Nies, Hua

Timeline

Spring ’12 Earth-Day kickoff presentation & workshop

Summer ’12 Site plan; conceptual building plan & drawings

Fall ’12 BMCT, Landsc, Arch, Eng, courses; Sust, Bldg. seminar

Spring ’13 MET course begins detailed design & site plan

Summer ’13 Site & materials prep., tech. drawings

Centers: Environment; Ecological Sustainability; Energy; Climate, Water

Programs: Eco, Sci & Engin, (grad); Eco, & Enviro,Engin, (undergrad)
Phipps Conservatory, Pittsburgh $20M; LBC certified

Urban environment: recreating habitat, ecosystem services that Ross Reserve already has

How to evaluate building environmental performance over a building’s life cycle (Ming Qu)

Green building rating systems focus on the following five categories of building design and life cycle performance:

- Sustainable Sites
- Water Efficiency
- Innovation in Design
- Indoor Environmental Quality
- Energy & Atmosphere
- Materials & Resources

If Purdue does a Living Building Challenge building, it will be the first for a state university
LEED-NC 2009

<table>
<thead>
<tr>
<th>Category</th>
<th>Maximum Points</th>
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<tr>
<td>1. Sustainable Sites</td>
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<td>2. Water Efficiency</td>
<td>10</td>
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<td>3. Energy and Atmosphere</td>
<td>35</td>
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<tr>
<td>4. Materials and Resources</td>
<td>14</td>
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<td>5. Indoor Environmental Quality</td>
<td>15</td>
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<td>6. Innovation and Design Process</td>
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<td>7. Regional Priority Credits</td>
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<td><strong>Total Possible Points</strong></td>
<td><strong>110</strong></td>
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Embedded Energy of Common Construction Materials

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<thead>
<tr>
<th>Material</th>
<th>MMBtu*</th>
<th>Embedded Energy</th>
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<tbody>
<tr>
<td>Aggregate</td>
<td>0.1</td>
<td>120</td>
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<tr>
<td>Concrete (30 Mpa)</td>
<td>1.3</td>
<td>3,190</td>
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<tr>
<td>Lumber</td>
<td>2.2</td>
<td>1,380</td>
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<tr>
<td>Brick</td>
<td>2.1</td>
<td>5,710</td>
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<tr>
<td>Cellulose insulation</td>
<td>3.3</td>
<td>112</td>
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<tr>
<td>Mineral wool insulation</td>
<td>14.4</td>
<td>139</td>
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<tr>
<td>Fibreglass insulation</td>
<td>18.3</td>
<td>370</td>
</tr>
<tr>
<td>Polystyrene insulation</td>
<td>17.5</td>
<td>3,775</td>
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<tr>
<td>Opacuous insulauant</td>
<td>8.1</td>
<td>3,440</td>
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<tr>
<td>Particleboard</td>
<td>8.8</td>
<td>5,670</td>
</tr>
<tr>
<td>Plywood</td>
<td>10.4</td>
<td>5,200</td>
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<tr>
<td>Aluminium</td>
<td>22.5</td>
<td>305,790</td>
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<tr>
<td>Aluminium (recycled)</td>
<td>8.2</td>
<td>21,870</td>
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<tr>
<td>Steel</td>
<td>32.9</td>
<td>250,200</td>
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<tr>
<td>Steel (recycled)</td>
<td>8.9</td>
<td>37,210</td>
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<tr>
<td>Zinc</td>
<td>31.6</td>
<td>571,260</td>
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<tr>
<td>Copper</td>
<td>79.6</td>
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<td>PVC</td>
<td>78.9</td>
<td>96,620</td>
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<td>Limestone</td>
<td>116.0</td>
<td>1,585,900</td>
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<td>Carpet (synthetic)</td>
<td>144.0</td>
<td>84,990</td>
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<tr>
<td>Paint</td>
<td>10.3</td>
<td>117,800</td>
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<tr>
<td>Asphalt shingles</td>
<td>9.8</td>
<td>4,990</td>
</tr>
</tbody>
</table>

*MMBtu per thousand square feet

Imagine a building that, like a tree...
- unique canopy
- provides homes for animals
- beautiful in itself
- protects the water
- can offset for energy
- scores energy
- separates carbon
- provides shade and comfort
- repurposes itself
- grows on you
- interacts with other living things
- at the end of the life cycle
- to the earth to support a healthy future

Some great photos taken or the innovative design of Bernheim. More images available on the website: bernheim.org/centers.

To learn more about the sustainable design principles behind the nature center visit: Bernheim Nature Center.

Key Green Features
- Strategic & Conservation Gallery

PA Nature Conservancy HQ and Lehigh Gap Nature Center: High efficiency & visitor focus, but donors more concerned with protection & restoration of natural environment. Can hit the $250/ft² mark.
Revised concept emphasizing classroom: putting students into the green building and putting it up front for visitors.
ENERGY FOR ELECTRICAL USE
Estimated PV potential: 35,000kWh/y
Estimated PV use: 10,000–15,000kWh/y
Variables: equipment selection and frequency of use

ANTICIPATED APPLIANCES
- Refrigerator (1)
- Microwave (1)
- Dishwasher (1)
- Washer
- Dryer
- Computer
- Landscape lighting
- Security system
- WELL
- Standby generator
- Research equipment
- Hot water heater backup tanks and equipment

Plans advancing, but still plenty of room for innovation