

Climate Change and Green Buildings



DEP Cambria Office Building

Introduction

John Boecker, AIA

- 7group Partner
- Consultants on 32 LEED Certified Projects – 9 K-12 Schools
- Consulting currently on over 60 additional LEED Registered projects in 17 states & 7 countries – 28 additional K-12 Schools
- USGBC national LEED Steering Committee members
- USGBC International Task Force Co-Chair
- USGBC national Curriculum Committee immediate Past Chair
- USGBC LEED Faculty
- Under contract with USGBC to perform LEED reviews
- Under contract with Wiley for Integrative Design book (2009)
- Helped write and develop LEED
- USGBC member since 2000
- AIA Earth Day 2000 Top Ten in U.S.
- 3 of 15 projects selected by DOE to represent U.S. GBC Team
- Author of “LEED Services Profile” for *AIA Handbook of Professional Practice*
- 1998, 2001, 2003 PA Governor’s Awards for Environmental Excellence
- NESEA design awards 1st prize 2002 & 2003



Clearview Elementary

Environmental Imperatives

- Climate Change
- Potable Water
- Resource Destruction
- Habitat Health
- Pollution/Toxins



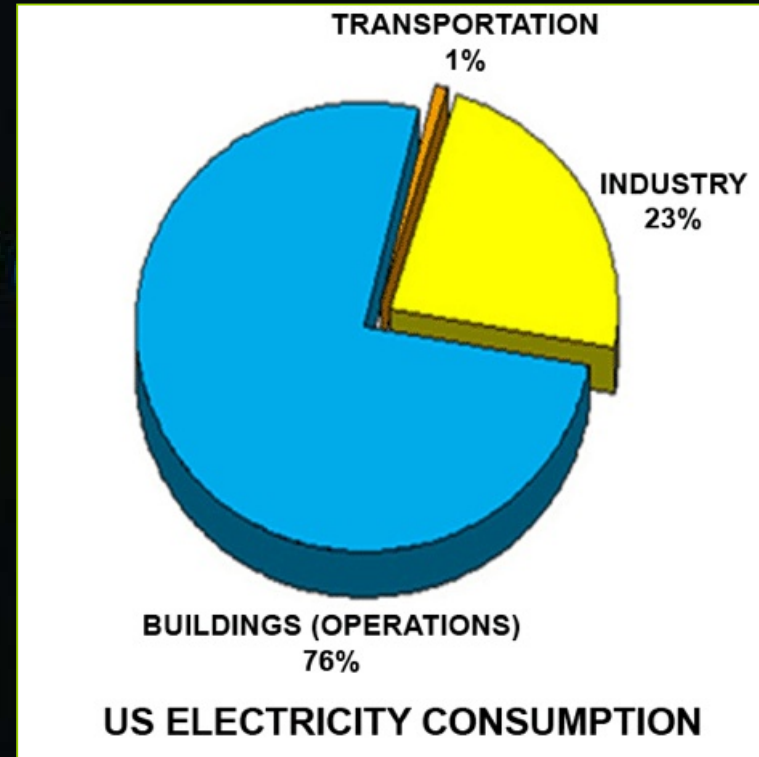
Impacts of Buildings

Buildings Consume:

- 40 % of raw materials
- 40% of processed materials
- 40% of total energy
- 16% of potable water supply

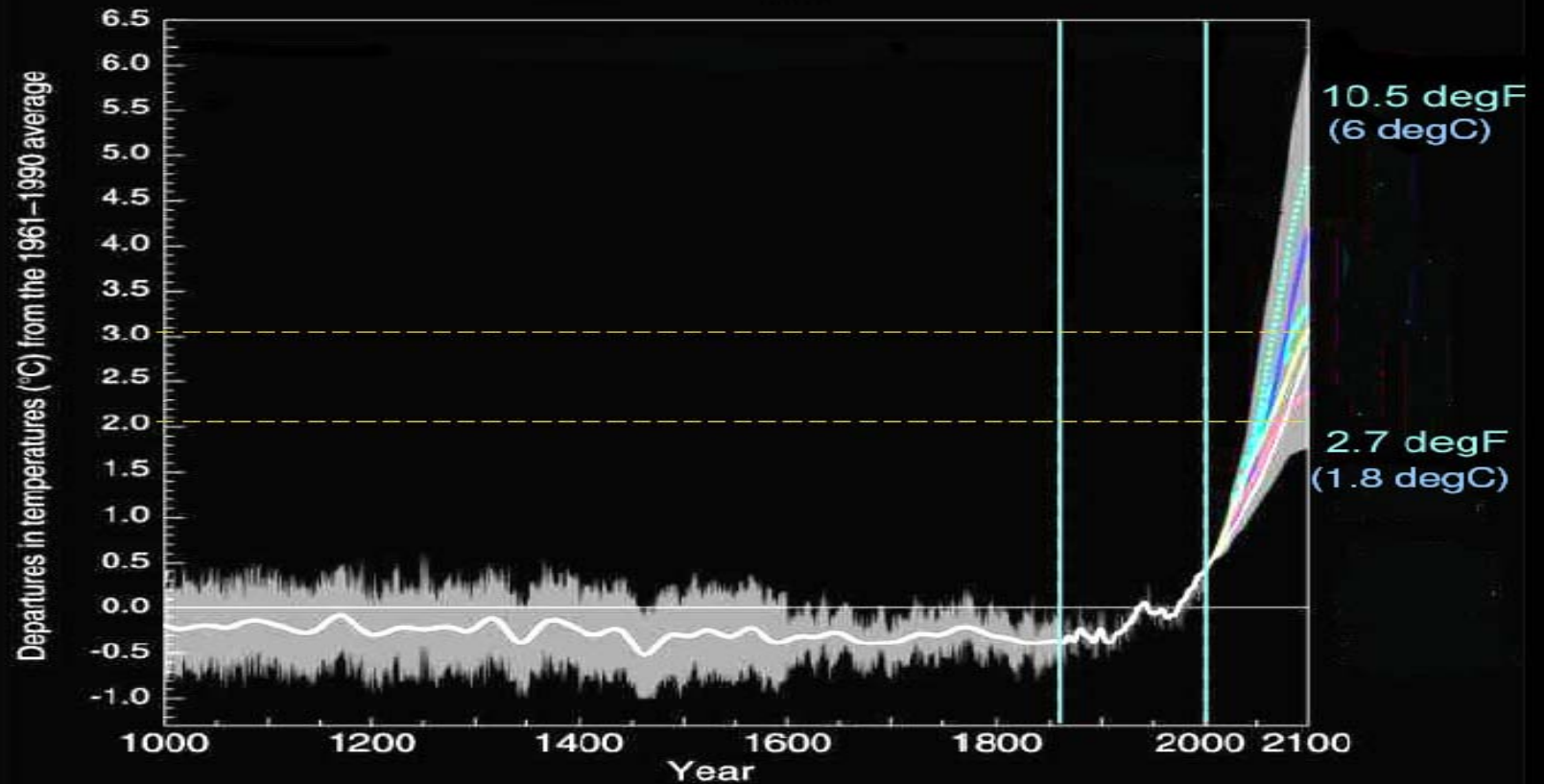
Buildings Produce:

- 40% of landfill waste
- 48% of CO2 emissions
- 50% of ozone-depleting CFC's



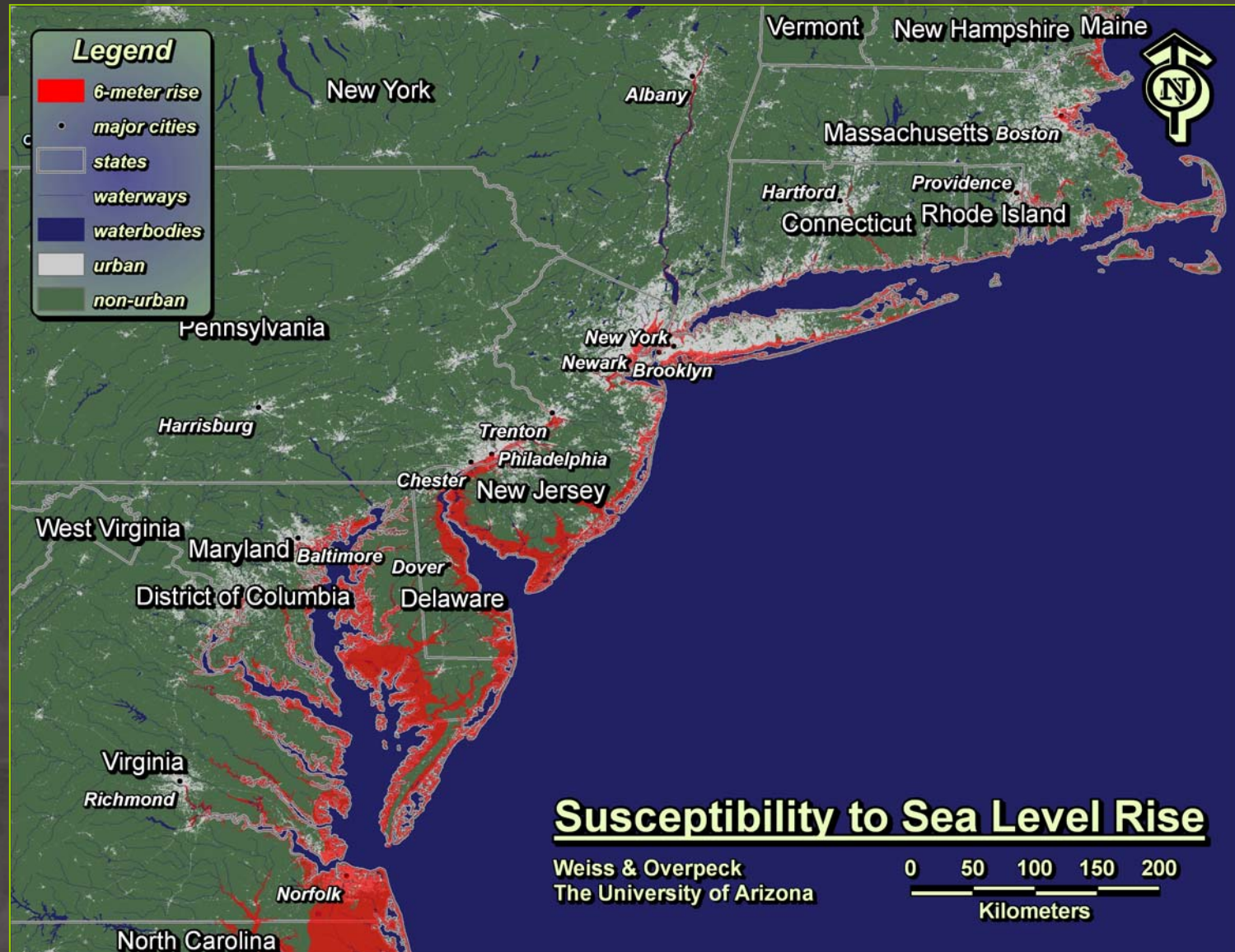
A Different Planet

Earths Surface Temperature



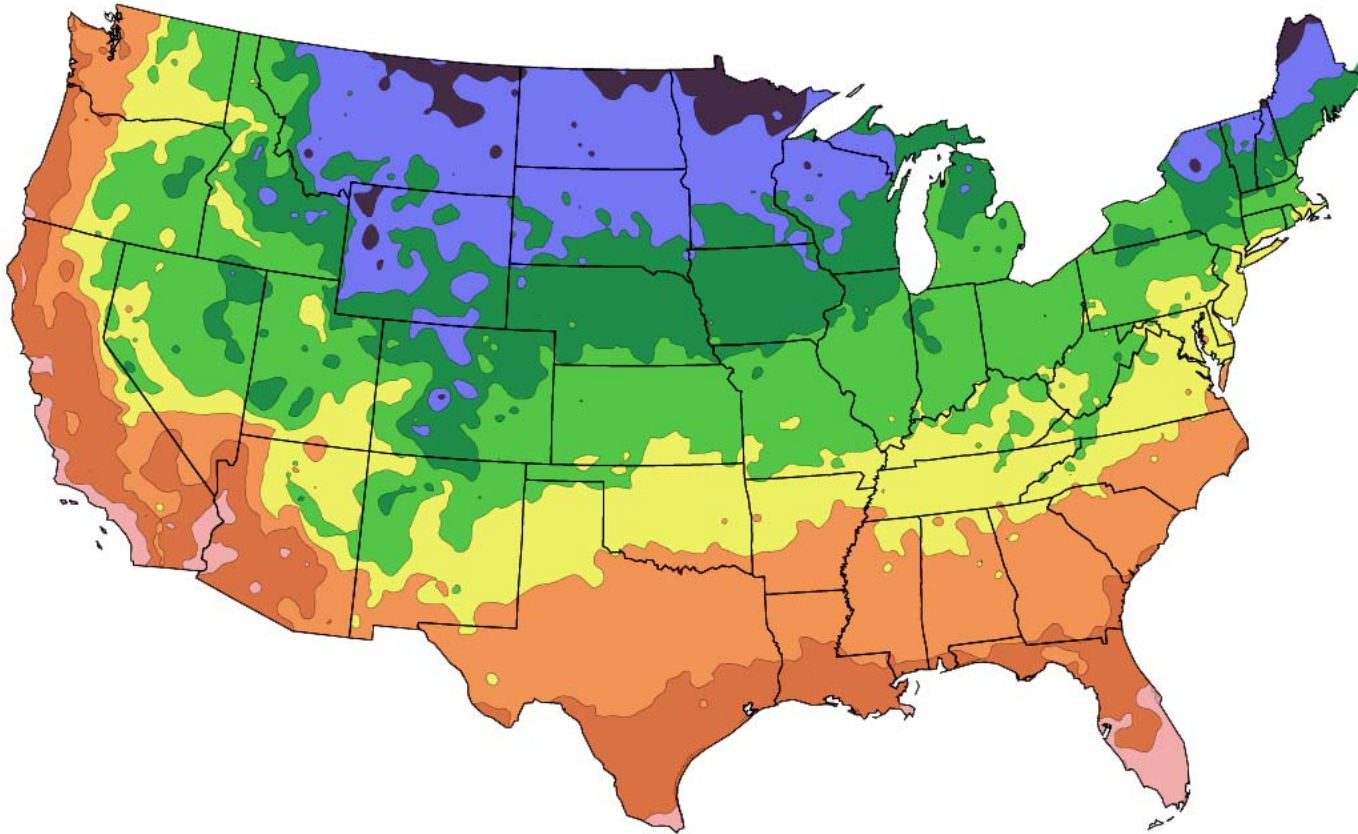
Source: UN Intergovernmental Panel on Climate Change (IPCC)

Climate Change Impacts



Climate Change Impacts

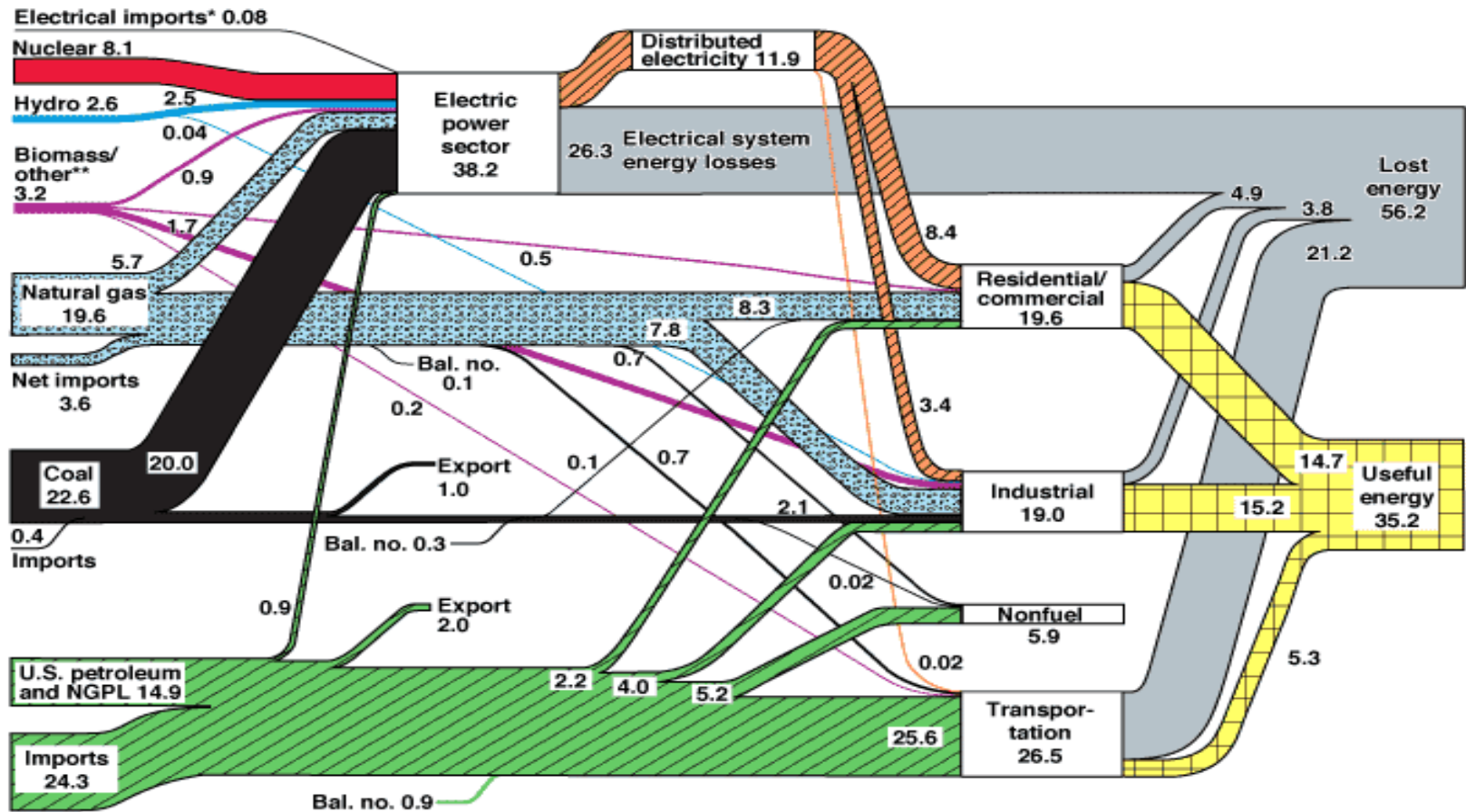
2006 Map



National Arbor Day Foundation Plant Hardiness Zone Map
published in 2006.

Useful Energy

U.S. Energy Flow Trends – 2002 Net Primary Resource Consumption ~97 Quads



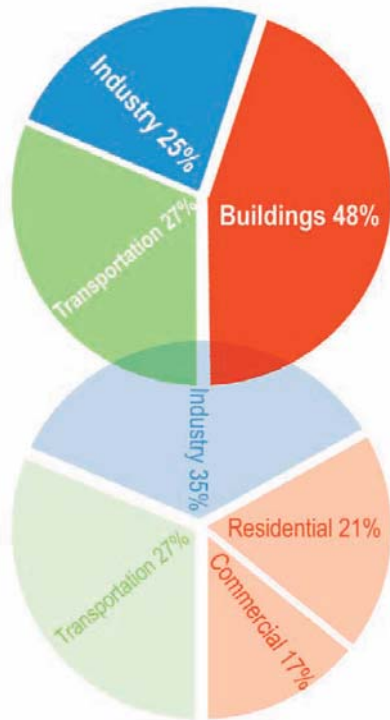
Source: Production and end-use data from Energy Information Administration, *Annual Energy Review 2002*.

*Net fossil-fuel electrical imports.

**Biomass/other includes wood, waste, alcohol, geothermal, solar, and wind.

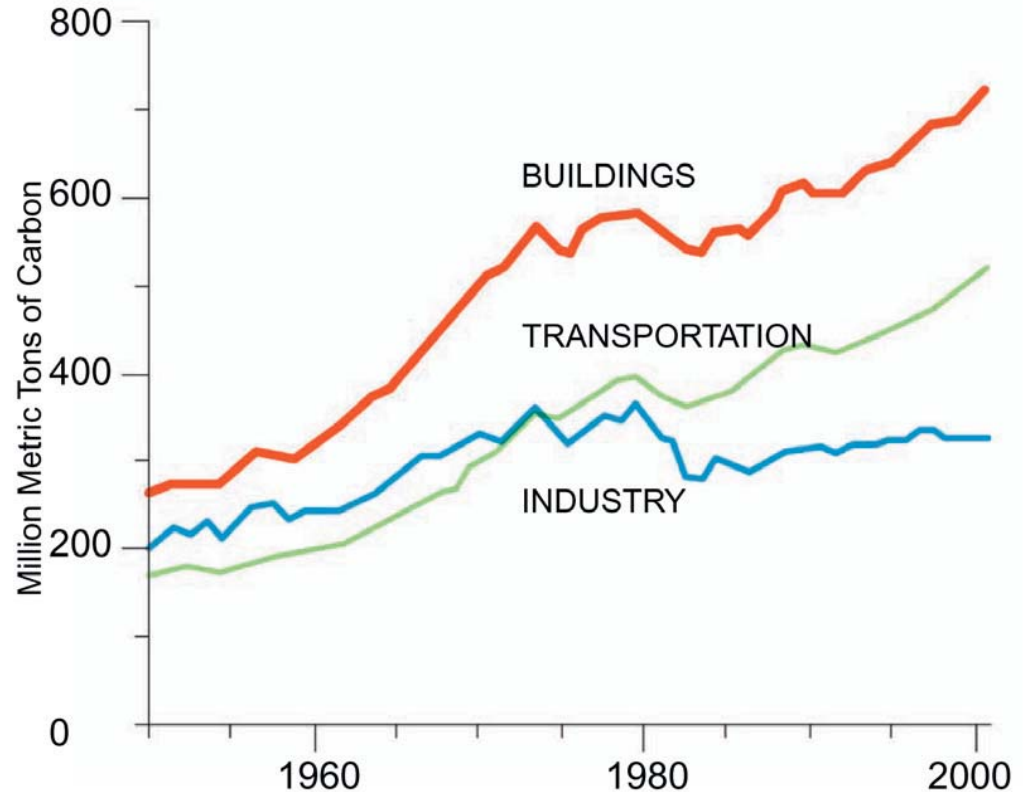
June 2004
Lawrence Livermore
National Laboratory
<http://eed.llnl.gov/flow>

Combined Building Operations & Embodied Energy



U.S. ENERGY CONSUMPTION BY SECTOR

Source: U.S. Energy Information Administration statistics
Graphic Published first in Metropolis Magazine, October 2003 Issue.



U.S. CO2 EMISSIONS BY SECTOR

Source: U.S. Energy Information Administration statistics

Primary Objectives of Green Buildings

Energy:

Reduce energy consumption and operational costs.

Materials:

Maximize the use of sustainable materials.



Air Quality:

Minimize negative impacts on interior air quality.

Productivity:

Improve the health, motivation and productivity of human occupants.

Green Buildings: Benefits & Interactions

- **Improved Occupant Performance**
- Reduced Operational Costs
- Reduced Environmental Impacts – CO2 reductions
- Better Indoor Air Quality
- Enduring Facilities
- Instructional Facilities
- **Daylighting**
- Enhanced Asset Value and Increased Profits
- Positive Public Image
- Optimized Life Cycle Economic Performance
- Contribute to Economic Growth
- Potentially No Increase in Construction Cost

Integrative Design: Building as an Organism

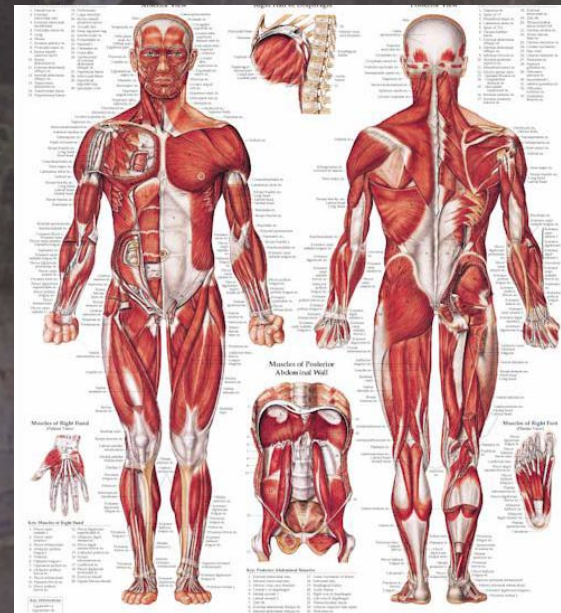
Systems Integration:

- Understanding relationships between systems
- Not a set of component parts
- Holistic, non-linear process
- Downsize or eliminate systems
- Analysis Tools

Energy modeling

Daylighting modeling

Materials analysis and impacts

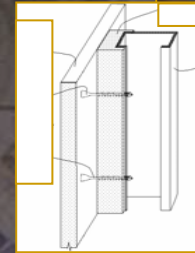


Case Study Example: HVAC System Sizing

Combining systems impacts to reduce cooling capacity

Air Conditioning ft2/ton

- Standard office building 250 - 400
- PA DEP Spec 600
- PA DEP Cambria Case Study 663

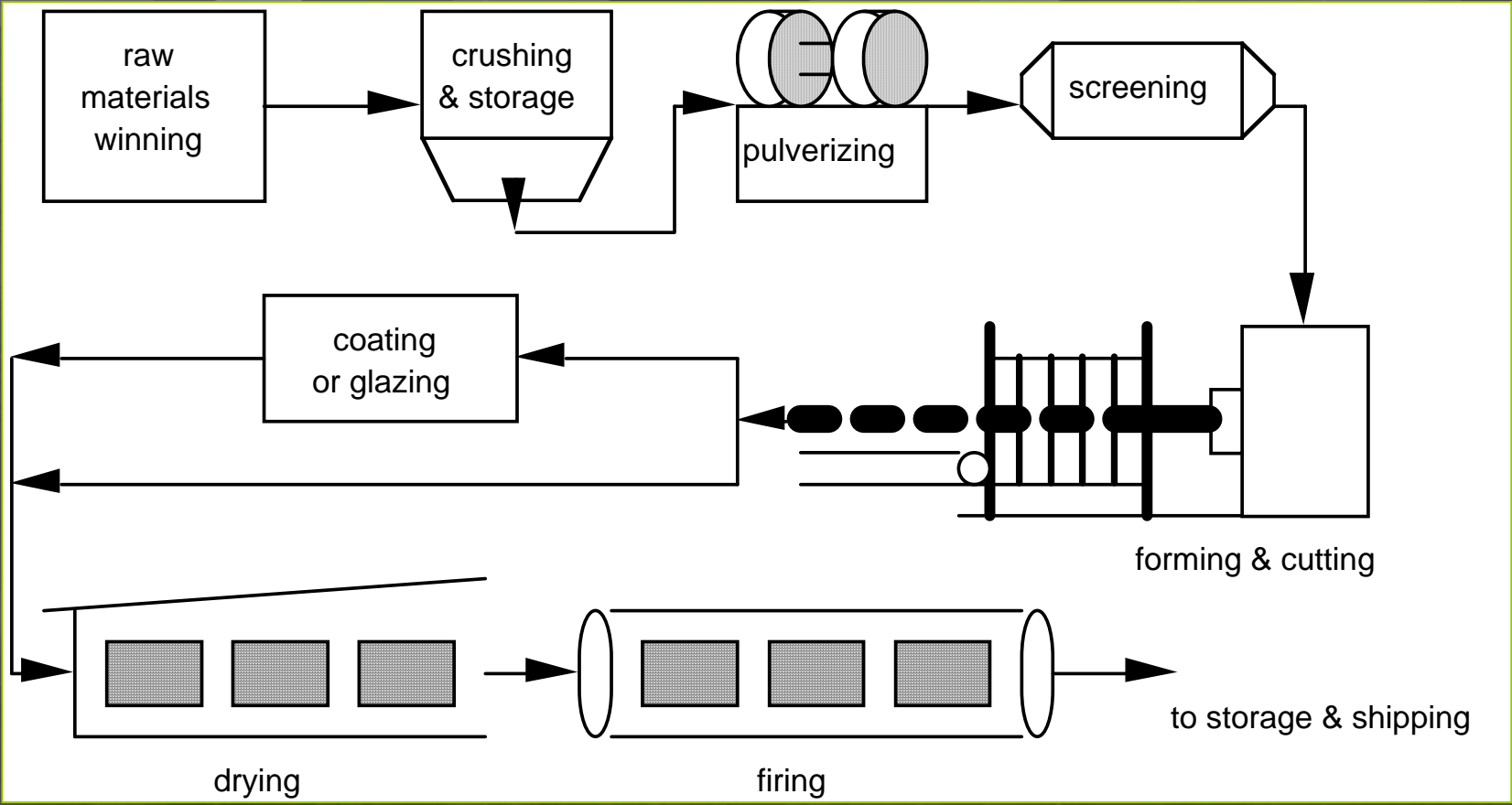


Embodied Energy: Life Cycle Inventory Analysis



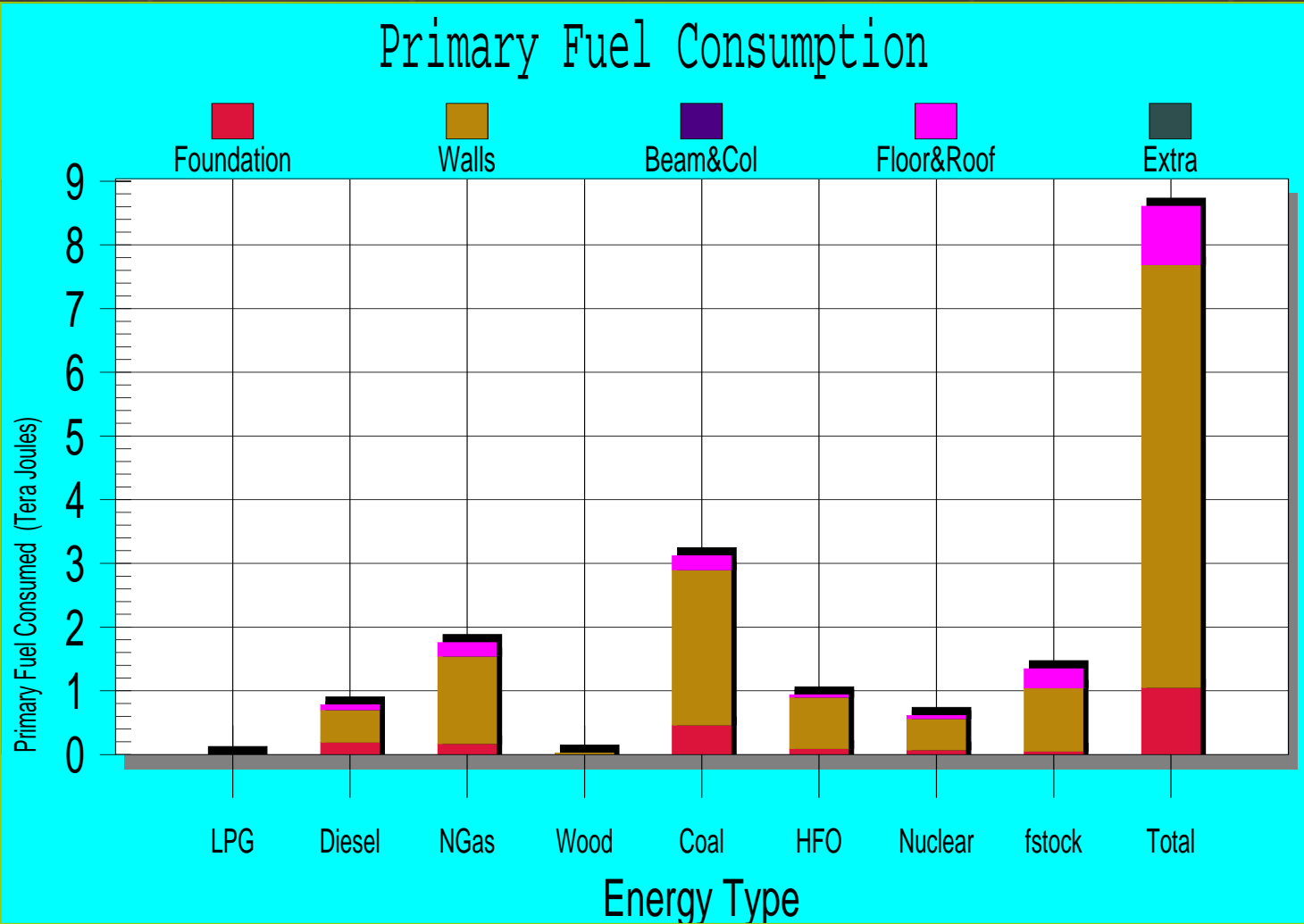
Slide from Greg Norris, Ph.D.

Example: Clay Brick Production Unit Processes



Slide from the Athena Institute

Embodied Energy by Building Component



Slide from the Athena Institute

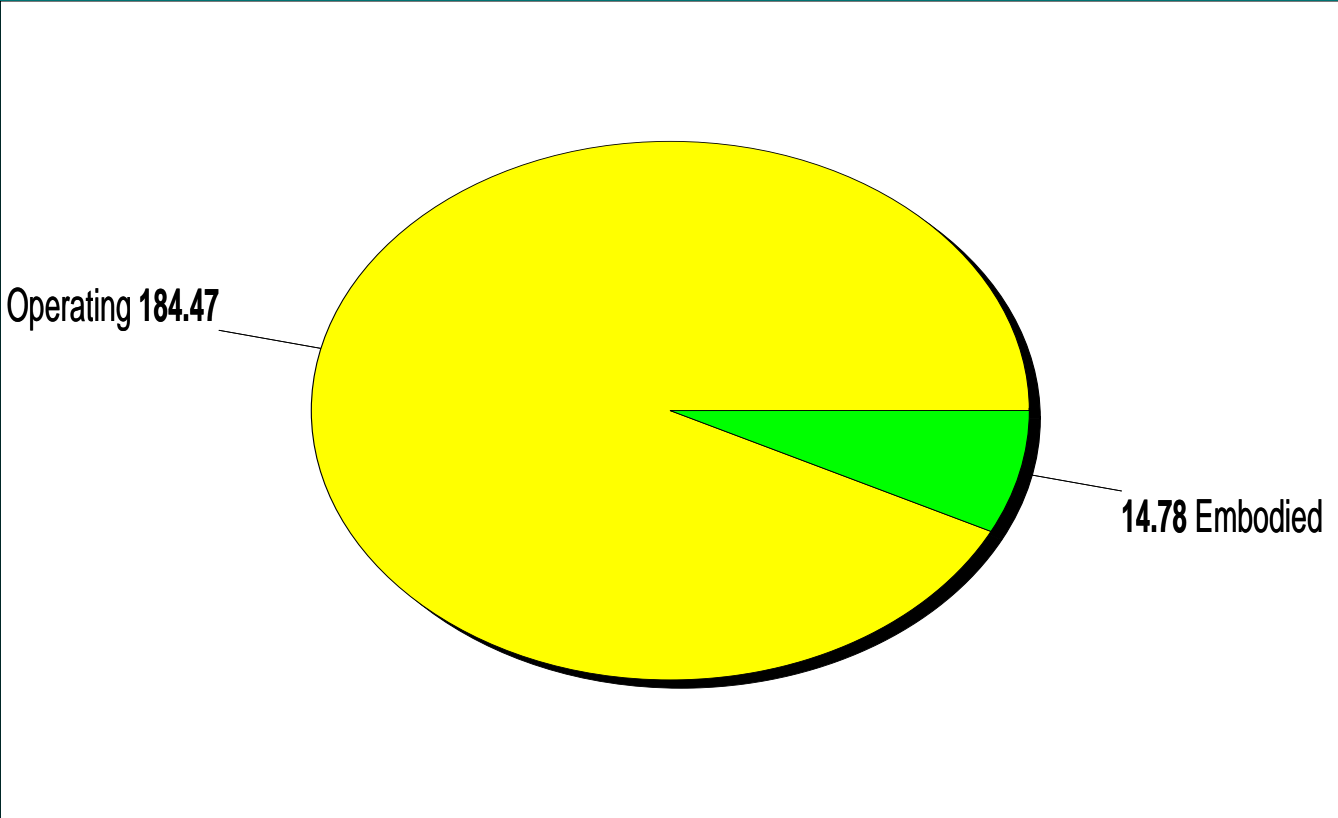
Annualized Embodied and Operations CO2 Equivalent

Normalized General Building Data	Normalized by net area		Units	Normalized by net area and occupancy		Units
	Benchmark	Design		Benchmark	Design	
	Annual consumption of delivered energy (presumed purchased)	459		289	MJ / m ² * yr	
Annualized embodied energy for above- and below-grade structure and building envelope	110	95	MJ / m ² * yr	539	467	(MJ/m ²) / (kaph/m ²) *yr
Total of annualized embodied energy and annual delivered energy	569	384	MJ / m ² * yr	2,801	1,891	(MJ/m ²) / (kaph/m ²) *yr
Total primary non-renewable fuels used on-site and for generation of electricity, annual basis	557	374	MJ / m ² * yr	2,743	1,844	(MJ/m ²) / (kaph/m ²) *yr
Predicted Greenhouse Gas Emissions from annual operations	61.2	54.3	Kg / m ² * yr	302	267	(Kg/m ²) / (kaph/m ²) *yr
Crude estimate of annualized embodied GHG emissions, Kg. CO2 equivalent (based on kg CO2 equivalent per GJ.)	16.0	13.9	Kg / m ² * yr	79	68	(Kg/m ²) / (kaph/m ²) *yr
Predicted total Greenhouse Gas Emissions from annual operations and annualized embodied emissions	77.3	68.2	Kg / m ² * yr	381	336	(Kg/m ²) / (kaph/m ²) *yr

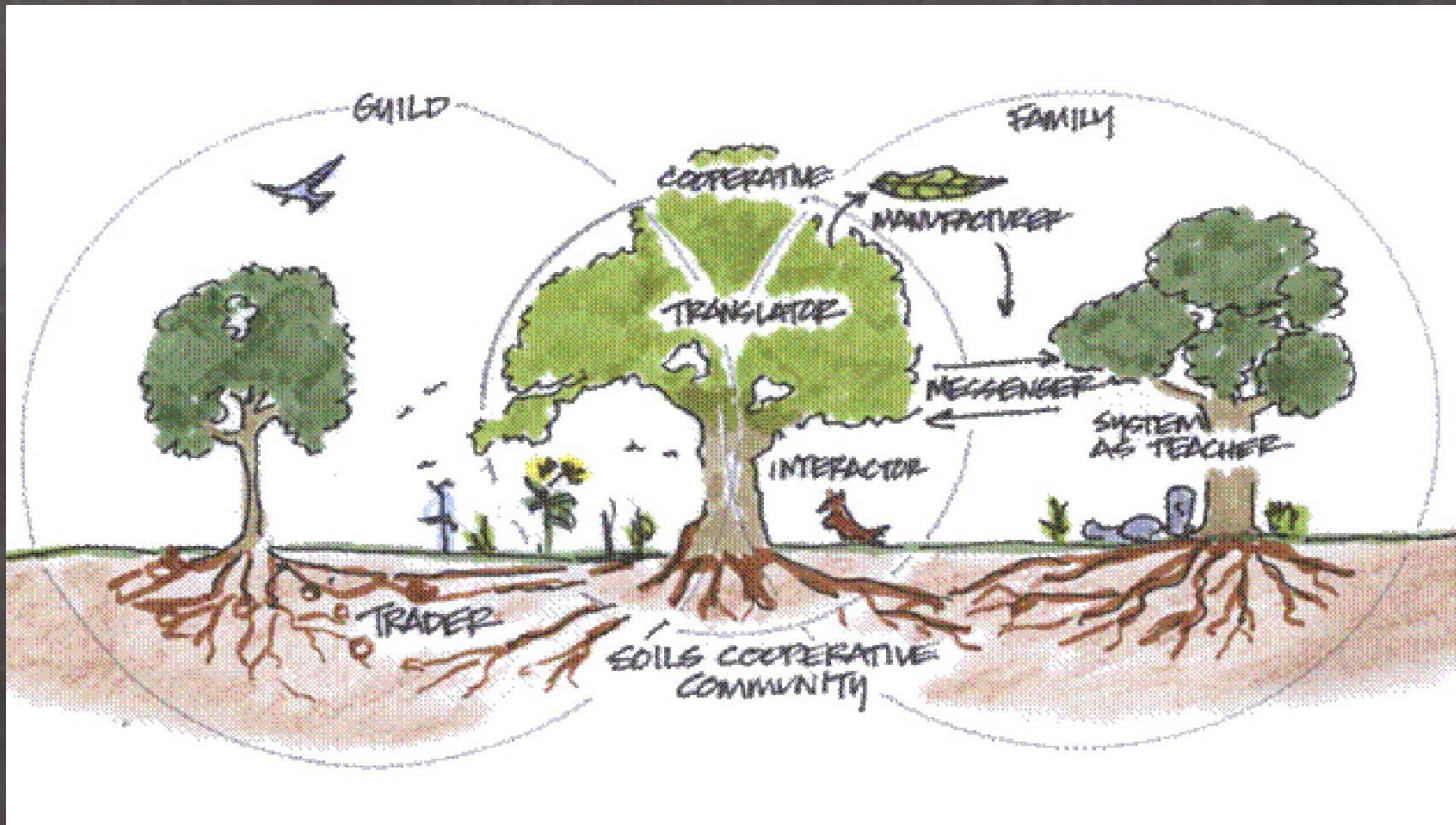
Life Cycle Assessment (LCA): ATHENA[®] Analysis

Operating vs Embodied Primary Energy Consumption

Primary Energy Consumed (Tera Joules)



Natural Systems as Our Model about Inter-relationships



From Permaculture Designers Manual, Bill Mollison

Natural Systems as Our Model



Image from Biohabitats, Inc.

Natural Systems as Our Model



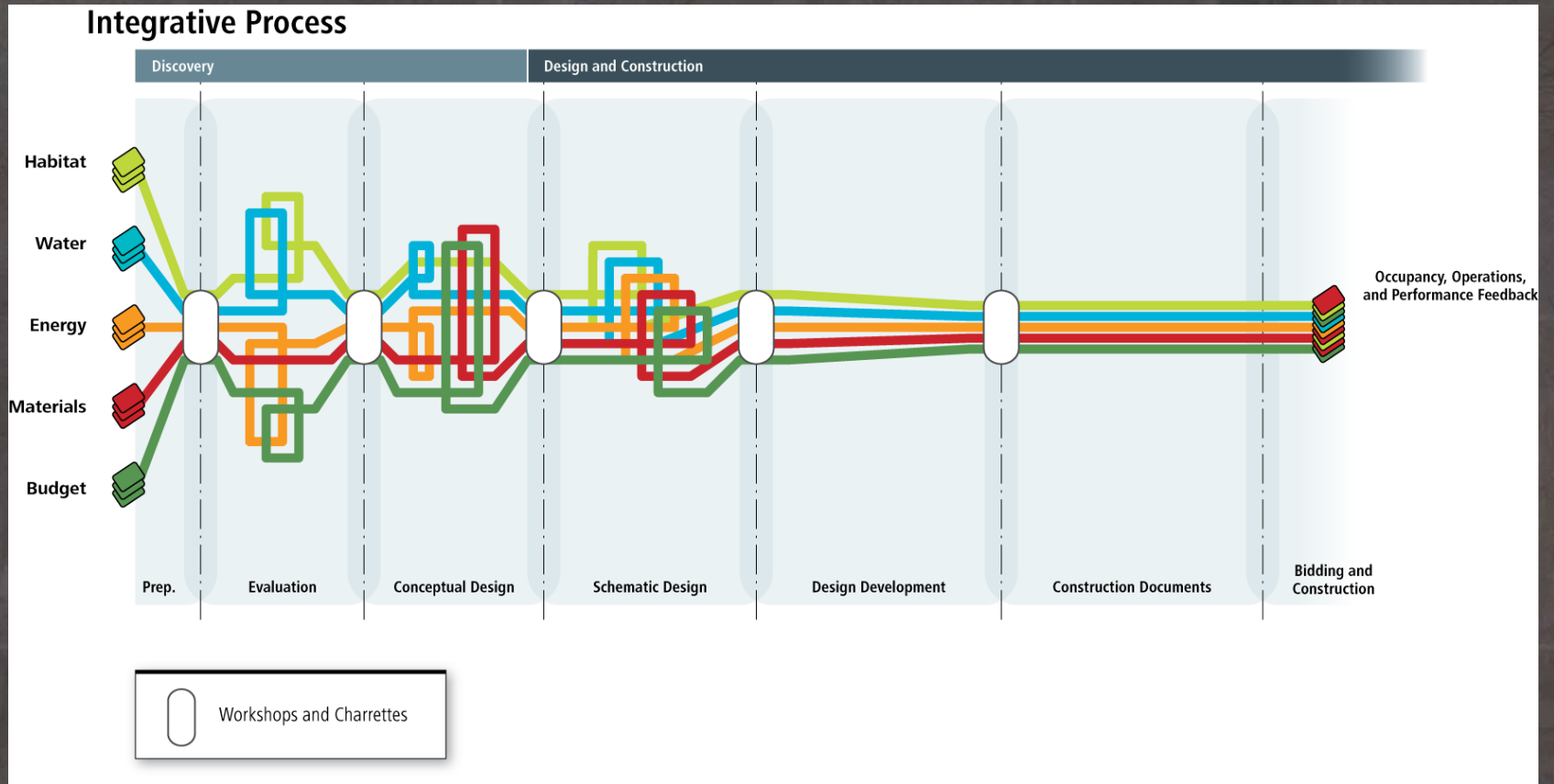
Image from Biohabitats, Inc.

Willow School Example



Images from Bill Reed

Integrative Design Process Overview





LEED™

LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

LEED-NC 2009 Rating System

Six Credit Categories:

- Sustainable Sites 8 credits - 26 points
- Water Efficiency 3 credits - 10 points
- Energy & Atmosphere 6 credits - 35 points
- Materials & Resources 7 credits - 14 points
- Indoor Environmental Quality 8 credits - 15 points
- Innovation & Design Process 2 credits - 6 points
- Regional Priority Credits 1 credit - 4 points



Total

35 credits - 110 points

LEED-NC 2009 Rating System

4 levels of certification

LEED Certified

Silver Level

Gold Level

Platinum Level



40 - 49 points

50 - 59 points

60 - 69 points

80 + points

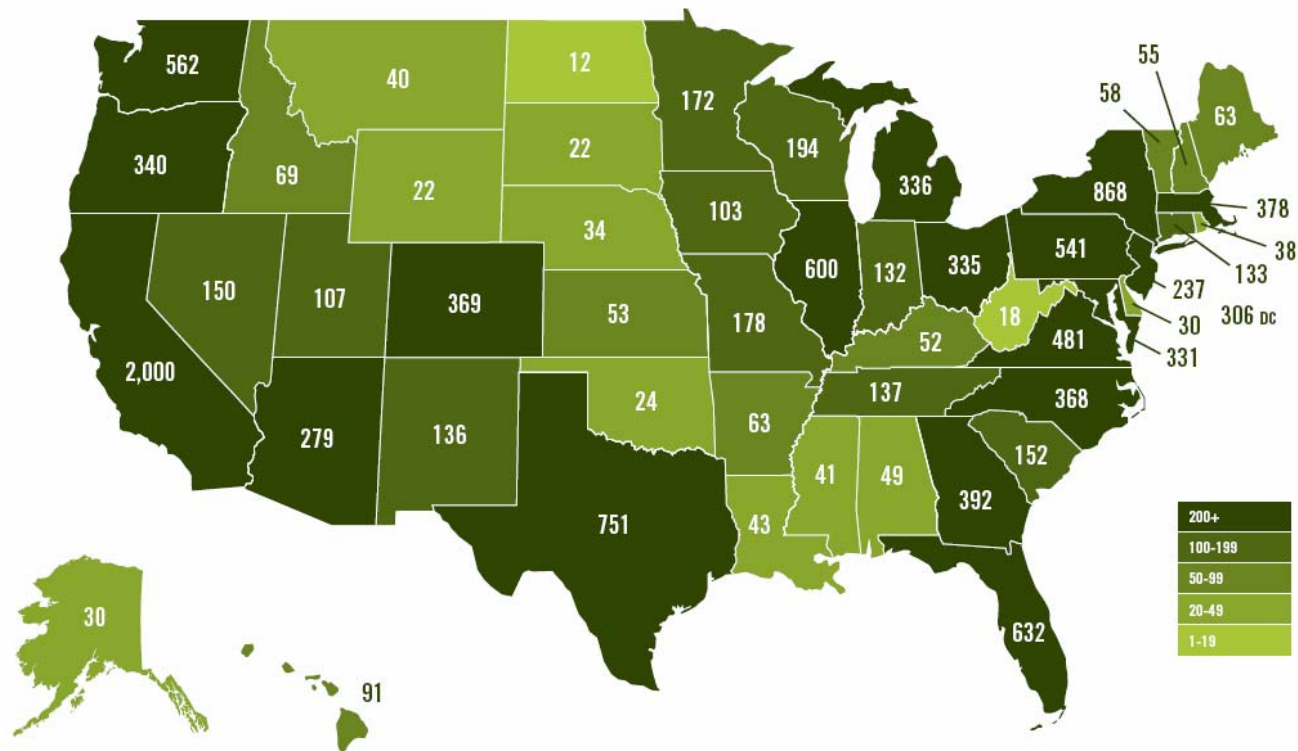
LEED 2009 Impact Weightings

Impact Category	Human Health	Ecosystem Health	Climate Change	Resource Depletion
Climate Change			25%	
Resource Depletion Fossil Fuel				9%
Human Health Criteria Pollutants	8%			
Water Intake				7%
Human Health Cancerous Effects	7%			
Ecological Toxicity		6%		
Eutrophication		5%		
Habitat Alteration		5%		
Human Health Noncancerous Effects	4%			
Photochemical Oxidant (smog) Formation	4%			
Acidification		3%		
Indoor Environmental Quality	15%			
Stratospheric Ozone Depletion	2%			
	40%	19%	25%	16%

LEED Market Transformation

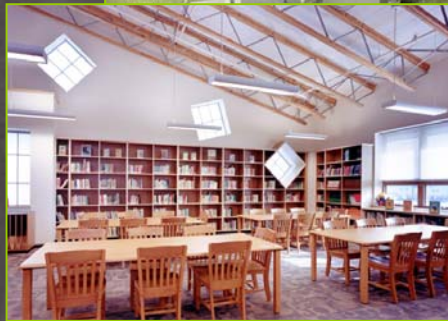
COMMERCIAL LEED PROJECTS BY STATE (REGISTERED AND CERTIFIED)

AS OF 5-31-08



Clearview Elementary School Case Study

- First LEED Certified School in PA



Clearview Elementary School

PowerDOE Energy Modeling Results

	Reference	As Designed	% Reduction
New Building Energy Use			
BTU/sf	75,581	23,628	69%
New Building Energy Cost			
\$/sf/yr	\$1.40	\$0.62	56%

DEP Cambria Case Study

- First LEED v2 Gold Certified Project in U.S.



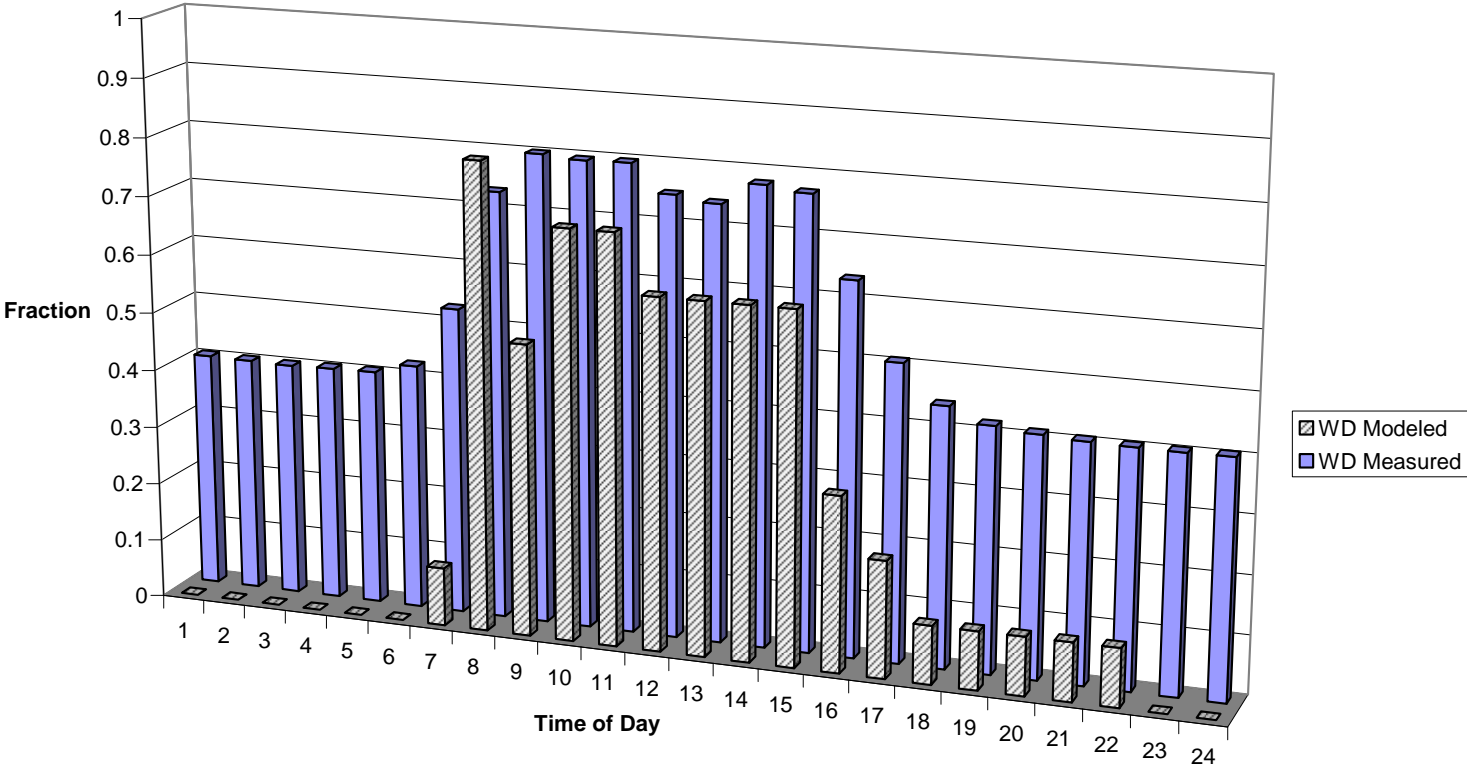
DEP Cambria

PowerDOE Energy Modeling Results

	Reference ASHRAE 90.1-1999	As Designed	% Reduction
New Building Energy Use			
Btu/sf/yr	46,436	22,335	52%
New Building Energy Cost			Actual = 43% ASHRAE 90-1-2001 & exclusive of PVs
\$/sf/yr	\$1.21	\$0.53	66%

Plug Load Schedule - Weekdays

DEP Ebensburg Equipment Schedules - Weekday



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WD Modeled	0	0	0	0	0	0	0.1	0.8	0.5	0.7	0.7	0.6	0.6	0.6	0.6	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0	0
WD Measured	0.404	0.403	0.402	0.404	0.405	0.422	0.527	0.732	0.801	0.796	0.797	0.751	0.742	0.779	0.771	0.635	0.507	0.443	0.418	0.411	0.407	0.405	0.405	0.406

2030 Challenge

Target 50% reduction in building's fossil fuel consumption currently

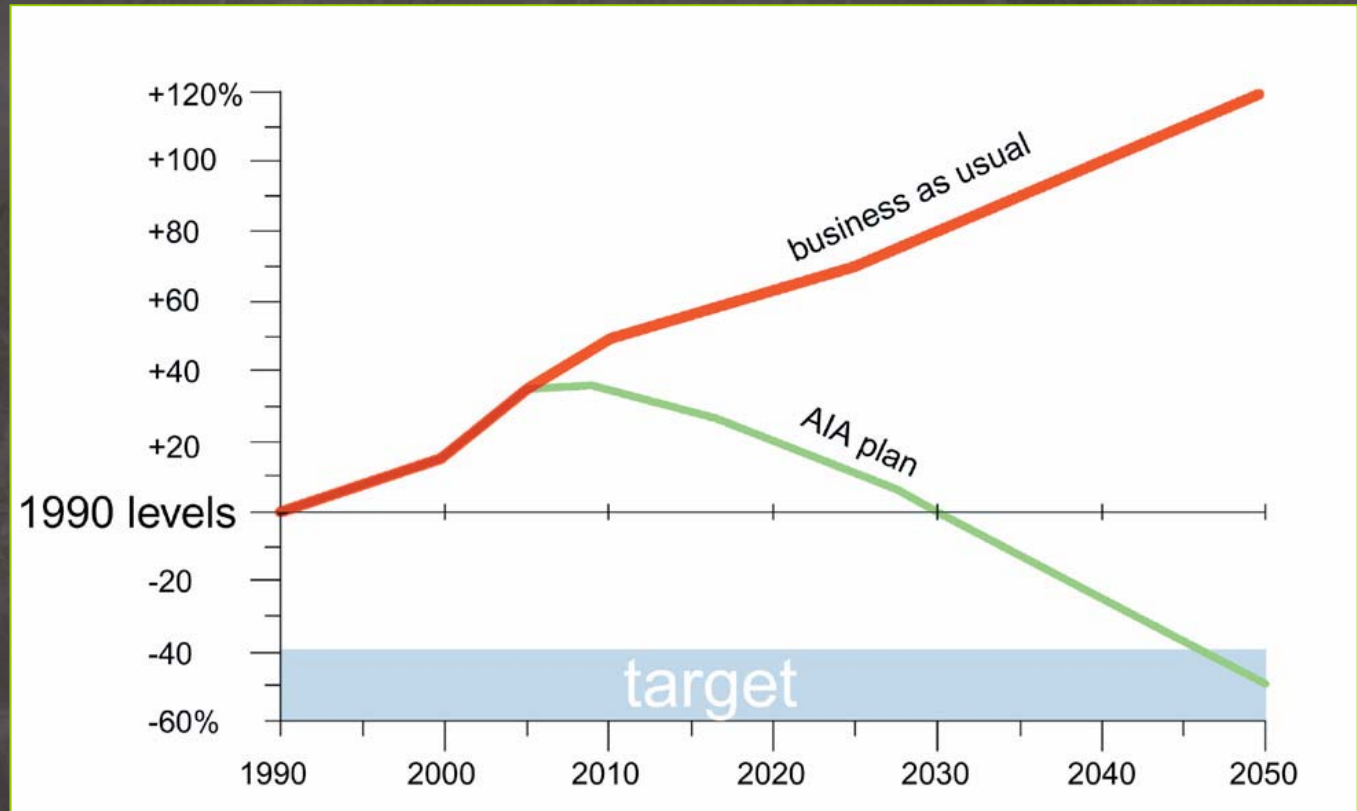
60% in 2010

70% in 2015

80% in 2020

90% in 2025

100% by 2030



. . . by 2035, three quarters of the built environment in the U.S. will be either new or renovated.

Information



www.sevengroup.com

www.2030challenge.org