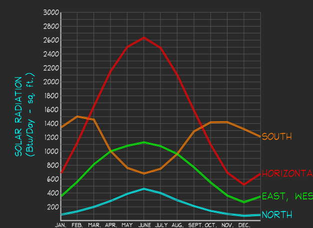
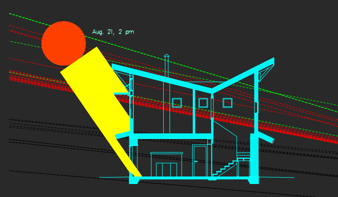




Energy Efficiency, Green Building, & the Integrated Design Process

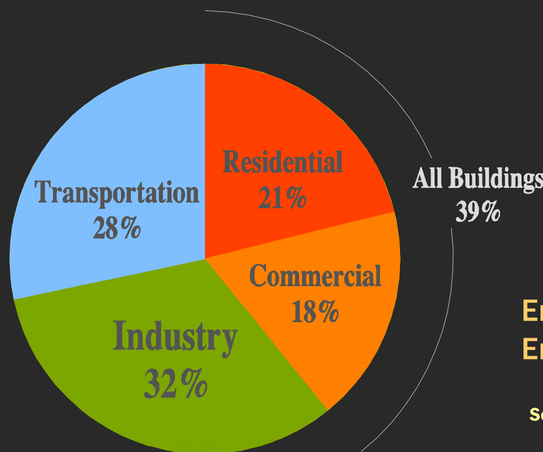
What is Green Building?

- Not a "style" of architecture (eg. Victorian or Modernist)
- Does not necessarily involve green paint
- Rather, Green Building is a philosophy on how to build, rooted in the belief that environmental destruction and health problems are not a necessary outcome of constructing and operating buildings.

Green Building is a holistic approach, considering:

- Energy
- Water
- Materials
- Indoor Environ. Quality
- Reducing Auto Dependence

Some Context for Green Building



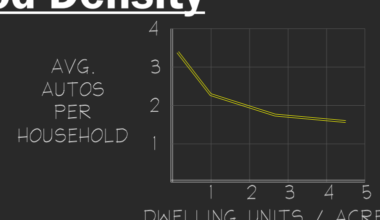
Energy Use in U.S. by End Use Sector

Source: US Energy Information Agency

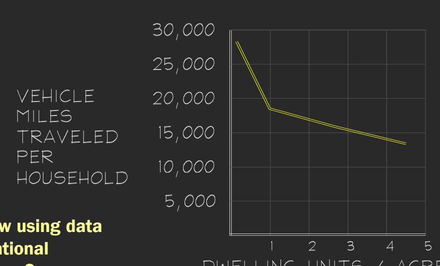
HIGH PLAINS ARCHITECTS

Relationship of Transportation & Neighborhood Density

Fewer cars per household in compact neighborhoods…



…and fewer vehicle miles traveled.

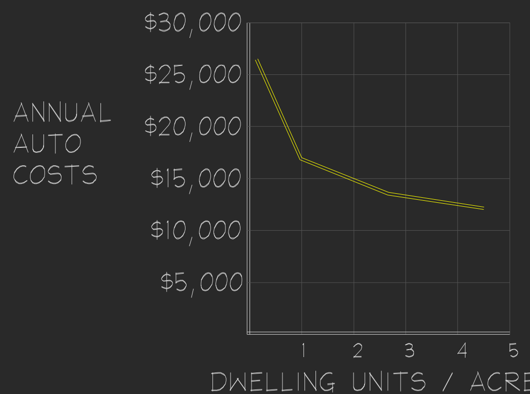


Source: John Holtzclaw using data from 1992 US DOT National Personal Transportation Survey

HIGH PLAINS ARCHITECTS

Relationship of Transportation & Neighborhood Density

Transportation costs decrease with compact communities



Source: Gulick, using John Holtzclaw data from 1992 US DOT National Personal Transportation Survey; Auto costs updated to reflect $5/gal gas

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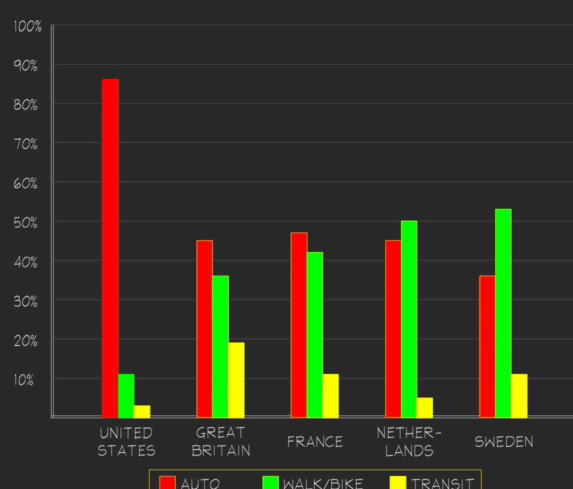
HIGH PLAINS ARCHITECTS

Relationship of Transportation & Neighborhood Density

Mode Split as % of Total Trips...



Source: Peter Calthorpe, The Next American Metropolis, 1993

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HIGH PLAINS ARCHITECTS

Green Building

Focuses on End Use

- Habitat Loss
- Air, Land, & Water Pollution

Extraction & Refining Losses

Generation & Transmission Losses

- Global Warming
- Air, Land, & Water Pollution

Primary Consumption

End Use Consumption

Analogous Diagram for Building Materials

HIGH PLAINS ARCHITECTS

Fine Cuisine

1) Quality Ingredients

Green Building

1) Quality "Green" Materials & Products:

HIGH PLAINS ARCHITECTS

Material & Product Certification Programs

- Provide third party verification for end user
- Give recognition & market differentiation to suppliers that achieve higher standards

Energy Efficiency	Recycled Content	Product Air Emissions	Sustainably Harvested Lumber	Non-toxic Ingredients

Fine Cuisine

1) Quality Ingredients

2) Good Recipe

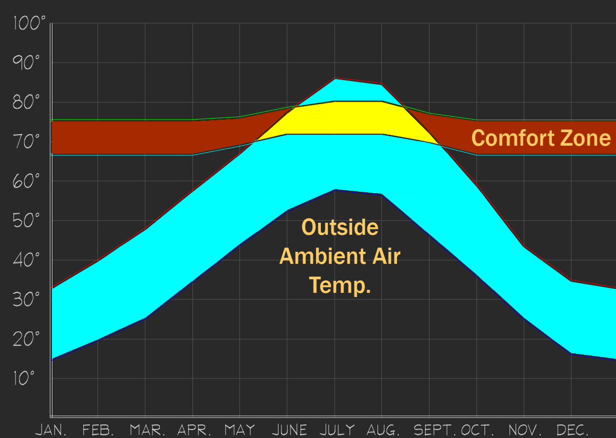
Green Building

1) Quality "Green" Materials & Products

2) Good Design

How the materials and products are configured is critical!

Energy Fundamentals: Comfort Zone

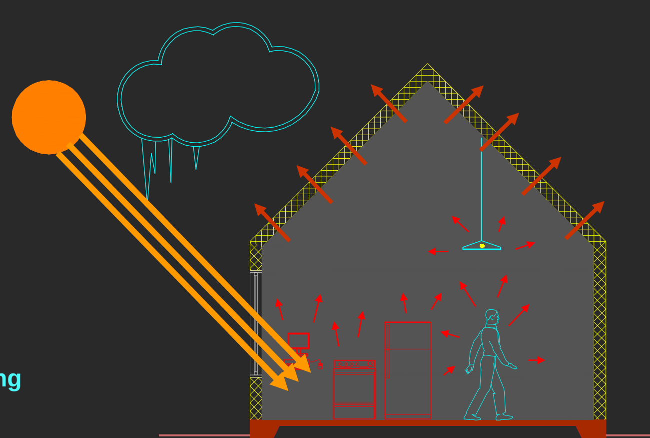


Energy Fundamentals: Heat Transfer

Variables

- Climate
- Sun
- Lighting
- Equipment
- Occupants

The Art of Green Building is balancing these variables to advantage.



Energy Strategy

1. Optimize building envelope to reduce demand for energy
   - Passive Solar Design
   - High levels of insulation
   - Daylighting
   - Natural ventilation
2. Recycle waste heat flows
   - Heat exchangers
3. Supply remaining demand for lighting, heating, & cooling with highly efficient electrical & mechanical systems
   - Radiant floor heating
   - Evaporative cooling
   - Daylight sensors for lighting
4. Maximize % of energy supply from renewable sources
   - On-site photovoltaic system
   - Off-site renewable energy credits
   - Solar hot water

Some Models for Inspiration…

Clipper Ship: 250 ft. long, 2,300 ton displacement
Design cleverly manipulates natural energy flows to propel ships 15-20 knots

Termite Mound: design uses solar gain, ventilation, & metabolism to maintain temperature range of 85-87 deg. F for fungi and egg production;

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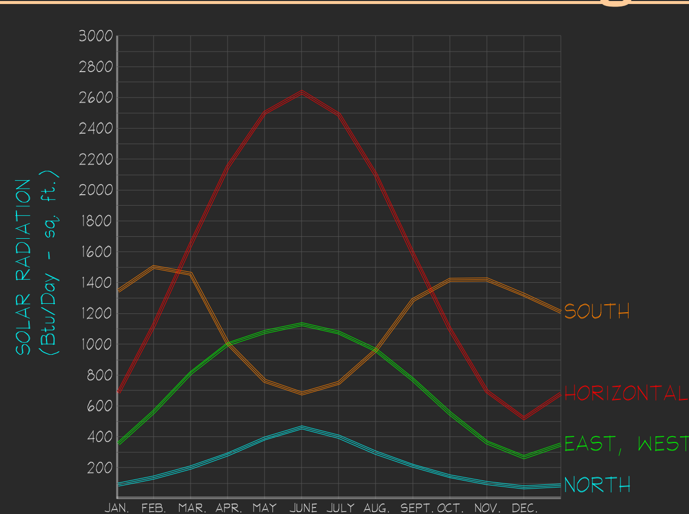
HIGH PLAINS ARCHITECTS

Solar Insolation @ 46 deg. N.



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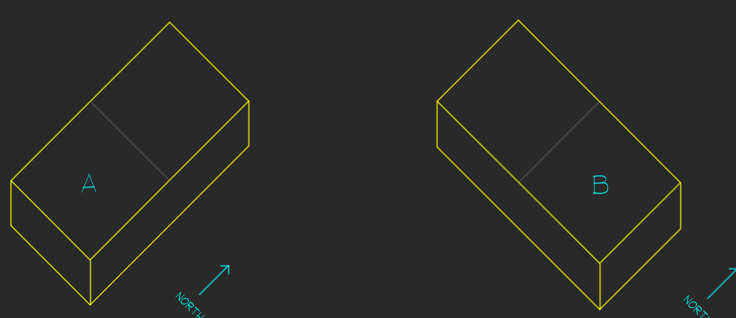
HIGH PLAINS ARCHITECTS

Building Orientation



Two buildings identical in size but different in orientation.

- Building 'B' receives 25% more solar energy on walls in January
- Building 'B' receives 18% less solar energy on walls in July

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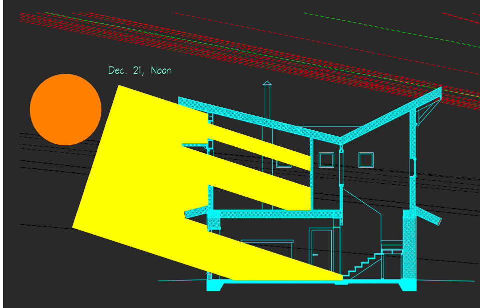
HIGH PLAINS ARCHITECTS

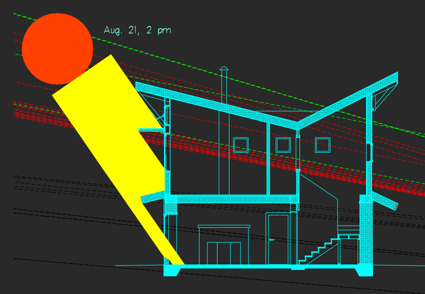
South Façade Design

Section



Admit winter sun through south-facing windows

Section

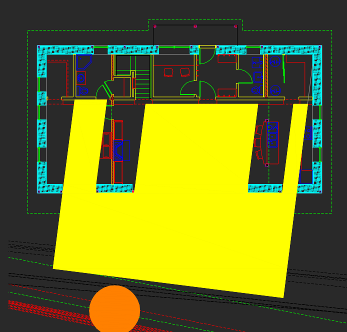


Shade windows from summer sun

HIGH PLAINS ARCHITECTS

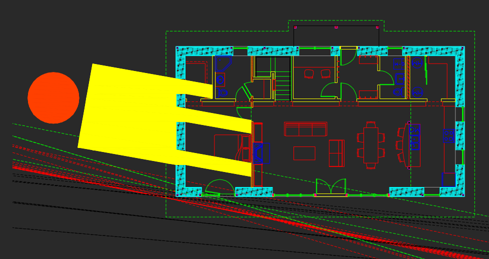
Window Size

Plan



Admit winter sun through large south-facing windows

Plan



Use small windows on east and west walls to limit admittance of low angle summer sun.

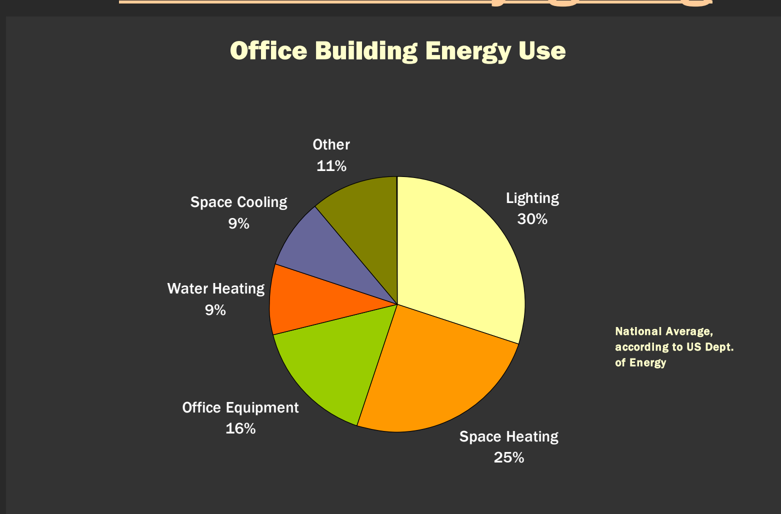
HIGH PLAINS ARCHITECTS

Super-insulated building envelope

Effective insulations that minimize *both* air infiltration & thermal conduction:

- Structural Insulated Panels (SIPs)
- Stabilized cellulose
- Water-based polyurethane foam
- Plastered straw bale

Context for Daylighting



Other Daylighting Aspects

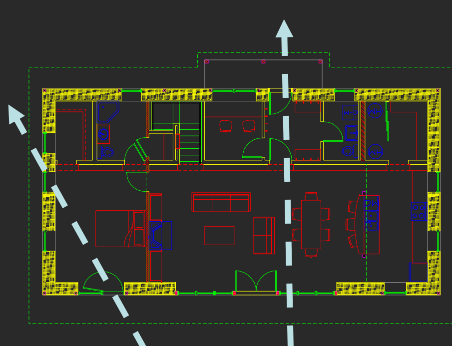
Stapleton Building - Billings, MT

Research confirms daylighting benefits:

1. 7-18% improvement on student test scores (comparing schools with most daylight vs. those w/ least in study)*
2. 31-49% higher sales per square foot (comparing stores with & without skylight daylighting in study)**
3. Office workers with good views—particularly vegetation—have 10-25% better memory recall (comparing offices with best views vs. offices without any views in study)***

*Daylighting in Schools, Heschong Mahone Group, 1999
**Skylighting & Retail Sales, Heschong Mahone Group, 1999
***Windows & Offices, Heschong Mahone Group, 2003

Natural ventilation



An effective night ventilation design eliminates need for costly air conditioning.

General rules of thumb:

1. Provide operable windows in all rooms
2. If possible, provide windows on two walls for cross ventilation in bedrooms
3. Night ventilation strategy: close windows in morning, open at night
4. Stack ventilation strategy: provide operable skylight, window, or exhaust fan in high space

Natural ventilation, continued

Research regarding operable windows

1. 1 - 11% increase in productivity for occupants who can control ventilation*
2. Increase in comfort zone for occupants who can operate windows**
3. 3.2% lower absenteeism in naturally ventilated buildings compared to mechanically ventilated buildings

*Estimates of Improved Productivity and Health from Better Indoor Environments, Fisk, W.J. & Rosefeld, A.H., 1997

**Developing an Adaptive Model of Thermal Comfort and Preference, de Bear, R., Brager, G., & Cooper, D. 1997

***The Impact of Different Ventilation Levels and Fluorescent Lighting Types on Building Illness, Sterling, E. & Sterling, T. 1983

Efficient Mechanical Systems

Energy Strategy:

1. Minimize energy demand with steps 3), 4), and 5)
2. Supply remaining energy needs with very efficient systems:
   - Radiant floor heating (20% more efficient than air-based system)
   - Evaporative cooling (400-500% more efficient in Montana's dry climate)

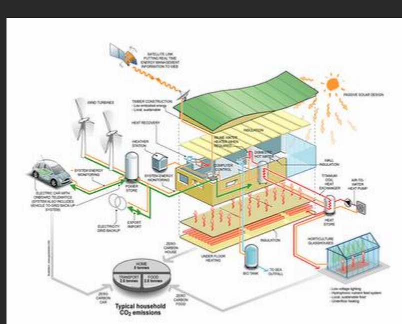
Renewable Energy

Renewable Strategy:

1. Design roof for solar orientation
2. Optimize mechanical systems for solar hot water heating
3. Make provision for both plumbing and electrical conduit to roof
4. Take advantage of current incentives for photovoltaic and solar hot water panels

Integrated Design Process

All decisions made about component parts affect the whole; optimize the system, not its parts.



- End Use/Least Cost Planning
- Performance Goals
- Whole Systems Design

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Integrated Design Process

Conventional Approach

- Building treated as a series of unrelated components
- Architect & Engineers have linear relationship
- Design building to meet prescriptive building codes
- After designed & built, "find out" how much energy it consumes

Green Approach

- Building treated as a system—components are inter-related *(building as ecosystem)*
- *Architect & Engineers have dialogical relationship*
- Develop performance goals before design
- Design building accordingly to meet performance goals

End Use / Least Cost Planning

Providing Comfort:

Air conditioning

vs. Passive design

Growing Sanitation Needs:

Increasing sewer & water treatment

vs. Reducing water demand w/ efficiency

Transportation Convenience:

Big parking lots

vs. Mixed use development

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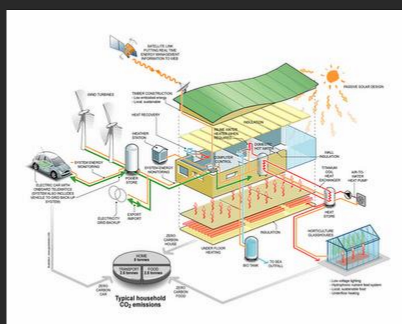
Performance Goals

Set performance goals *BEFORE* starting design



For Example:

- No air conditioning
- 25% more efficient than building codes
- Energy Star® or LEED® certification

LEED® can provide guidance…

USGBC

"The U.S. Green Building Council (USGBC) is a non-profit composed of leaders from every sector of the building industry working to promote buildings that are environmentally responsible, profitable and healthy places to live and work."

LEED

"The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings."

LEED rating system

Sustainable Sites

Water Efficiency

Energy & Atmosphere

LEED

LEED-NC Version 2.1 Registered Project Checklist
Home On The Range
Billings, Montana

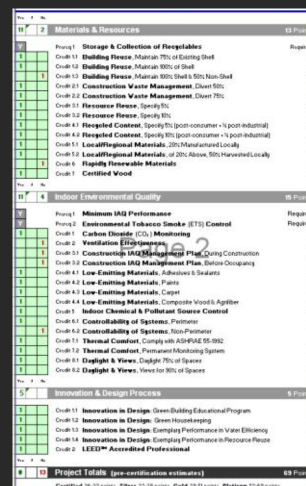
Yes	?	No			
10		4	**Sustainable Sites**		14 Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
1			Credit 1	**Site Selection**	1
		1	Credit 2	**Development Density**	1
		1	Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
1			Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling	1
		1	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
1			Credit 6.2	**Stormwater Management**, Treatment	1
1			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Ro	1
1			Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
		1	Credit 8	**Light Pollution Reduction**	1

Page 1

Yes	?	No			
4		1	**Water Efficiency**		5 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
		1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
1			Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
15		2	**Energy & Atmosphere**		17 Points
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
9		1	Credit 1	**Optimize Energy Performance**	1 to 10
1			Credit 2.1	**Renewable Energy**, 5%	1
1			Credit 2.2	**Renewable Energy**, 10%	1
1			Credit 2.3	**Renewable Energy**, 20%	1
1			Credit 3	**Additional Commissioning**	1
1			Credit 4	**Ozone Depletion**	1
		1	Credit 5	**Measurement & Verification**	1
1			Credit 6	**Green Power**	1

continued...



Yes	?	No			
11		2	**Materials & Resources**		13 Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
1			Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
1			Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
		1	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
1			Credit 2.1	**Construction Waste Management**, Divert 50%	1
1			Credit 2.2	**Construction Waste Management**, Divert 75%	1
1			Credit 3.1	**Resource Reuse**, Specify 5%	1
1			Credit 3.2	**Resource Reuse**, Specify 10%	1
1			Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	1
1			Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	1
1			Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
1			Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
1			Credit 7	**Certified Wood**	1

Yes	?	No			
11		4	**Indoor Environmental Quality**		15 Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
1			Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
		1	Credit 2	**Ventilation Effectiveness**	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	1
1			Credit 4.3	**Low-Emitting Materials**, Carpet	1
1			Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems**, Perimeter	1
		1	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
1			Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
1			Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
1			Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
1			Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Page 2

Yes	?	No			
5			**Innovation & Design Process**		5 Points
1			Credit 1.1	**Innovation in Design**: Green Building Educational Program	1
1			Credit 1.2	**Innovation in Design**: Green Housekeeping	1
1			Credit 1.3	**Innovation in Design**: Exemplary Performance in Water Efficiency	1
1			Credit 1.4	**Innovation in Design**: Exemplary Performance in Resource Reuse	1
1			Credit 2	**LEED™ Accredited Professional**	1

Yes	?	No			
[illegible]		13	**Project Totals** (pre-certification estimates)		69 Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

Materials & Resources

Indoor Environmental Quality

Innovation & Design Process

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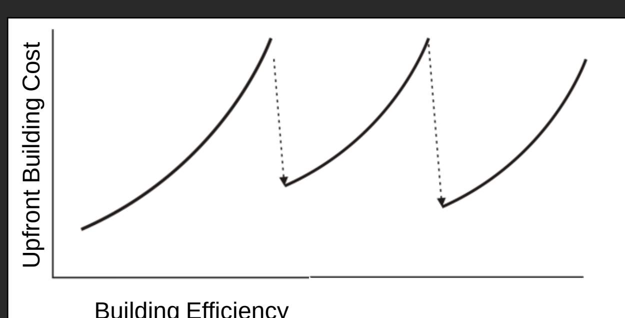
HIGH PLAINS ARCHITECTS

Whole Systems Thinking



"Tunneling through the cost barrier" (Rocky Mtn. Institute)

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HIGH PLAINS ARCHITECTS

Integrated Design Attributes:

- Focus on demand as well as supply
- Materials and products do double or triple duty
  - Concrete floors
  - Operable windows
  - Low-e glazing
  - Green cleaning products

HIGH PLAINS ARCHITECTS

Fine Cuisine

1) Quality Ingredients
2) Good Recipe
3) Talented Chef

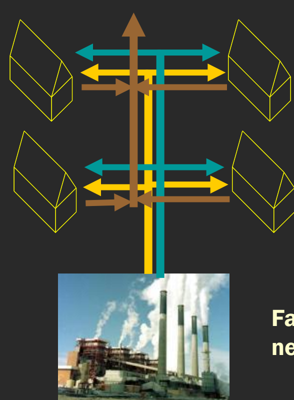
Green Building

1) Quality “Green” Materials & Products
2) Good Design
3) Invested Contractor

HIGH PLAINS ARCHITECTS

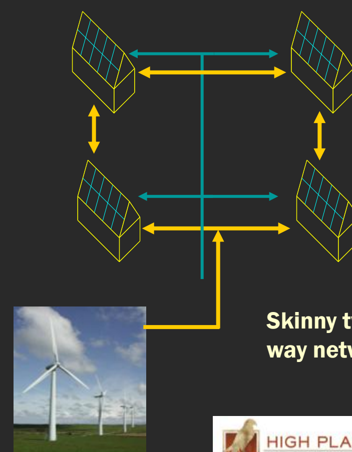
Paradigm Shift: Buildings as both Producers & Consumers

Buildings as units of consumption only



Fat one-way networks

Buildings as units of both consumption & production



Skinny two-way networks

Paradigm Shift: Buildings as both Producers & Consumers

Distributed Generation Benefits

- Reduced transmission losses
- More robust (not as vulnerable to disruption)

Rainwater Collection Benefits

- Reduced energy to pump water uphill
- Match treatment levels to end use

On-site Waste Treatment Benefits

- Eliminate pollution of potable water
- Re-create the nutrient cycle—turn a liability into an asset

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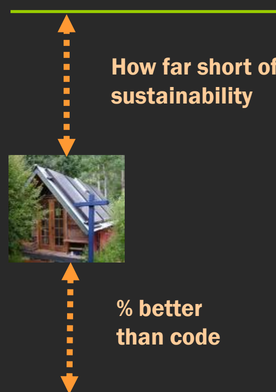
Green Building vs. Sustainable Building



Sustainable Building uses measure of "sustainability" as reference point

<u>eg. Living Building Challenge:</u>
- Build only on previously developed land
- Operate within current solar budget
- No toxic materials like PVC
- Water only from rainwater catchment
- Purchase carbon offsets for materials

Green Building uses "conventional" or current building codes as reference point

Home on the Range

The story of a LEED Platinum certified green building

The Owners…

- Northern Plains Resource Council organizes Montana citizens to protect our water quality, family farms and ranches, and unique quality of life.
- WORC's mission is to advance the vision of a democratic, sustainable, and just society through community action.

…wanted to "live their values."

The existing building…

- Grocery store built in 1940s
- Uninsulated, nearly windowless
- Large walk-in coolers and freezers
- Derelict eyesore when purchased

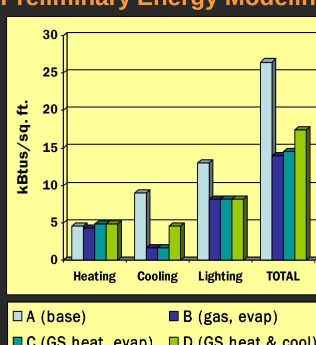
Integrated Design Process

Performance Goals

- Demonstration green building
- LEED certification from US Green Building Council
- Work within tight budget

Energy Strategy

Preliminary Energy Modeling

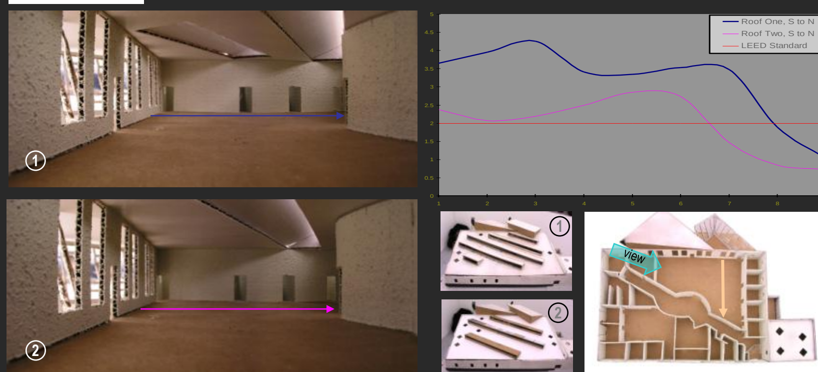


- Energy modeling: tool to achieve performance goals early in design process
- Indicated importance of daylighting strategy

1. Optimize building envelope to reduce demand for energy
   - High levels of insulation
   - Daylighting
2. Recycle waste flows of energy
   - N/A
3. Supply remaining demand for lighting, heating, & cooling with highly efficient electrical and mechanical systems
   - Radiant floor heating
   - Evaporative cooling
   - Daylight sensors for lighting
4. Maximize % of energy supply from renewable sources
   - 9.9 kW photovoltaic system
   - Solar hot water

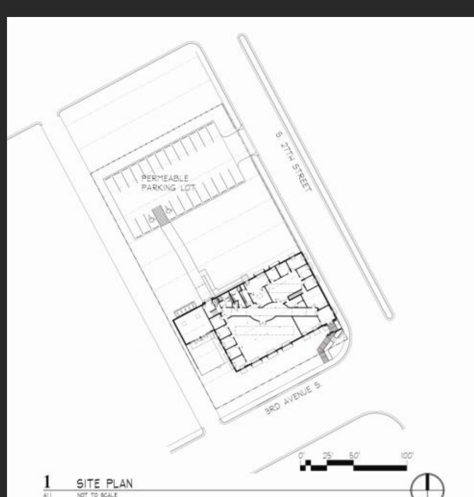
Design Process: Daylighting

BETTERBRICKS DAYLIGHTING LAB SEATTLE



Daylighting model to test effectiveness of clerestories

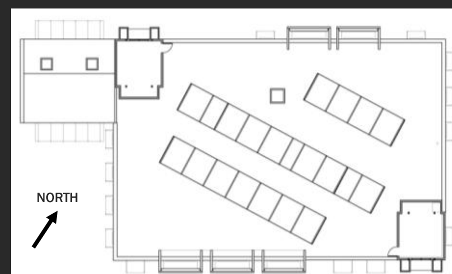
Design: Site



- Downtown Billings street grid oriented 35 deg. off of cardinal directions
- Clerestory monitors oriented for maximum daylighting & solar energy
- Parking located away from building

Design: Floor Plan

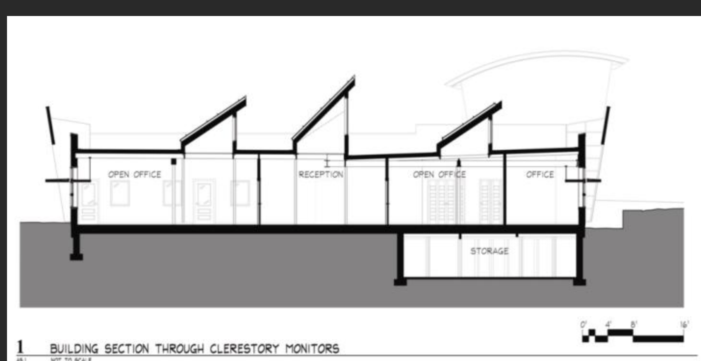
Main Floor Plan



Roof Plan

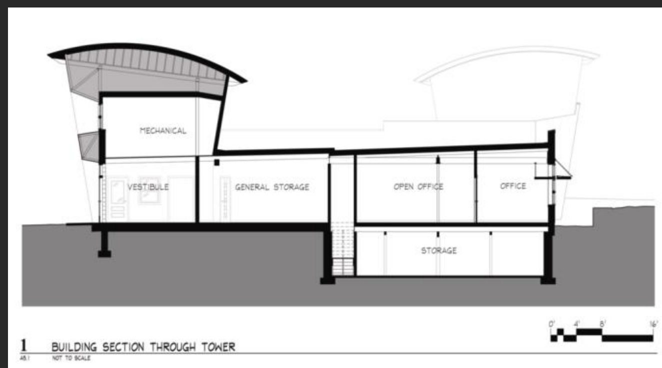
- Gallery/circulation space runs diagonally to connect principal entrances
- Rooftop monitors correspond with gallery orientation (due east-west)

Design: Section thru Monitors



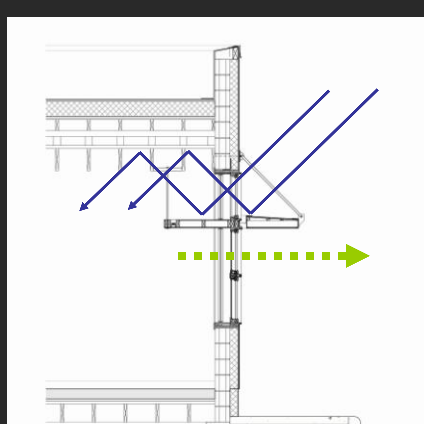
- Perimeter daylighting strategy: light shelves
- Building core daylighting strategy: north-facing clerestory monitors
- Solar panels on south-facing slope of monitor roofs

Design: Section thru Tower



- Entry towers double as mechanical rooms for evaporative cooling

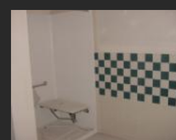
Design: Typical Wall Section

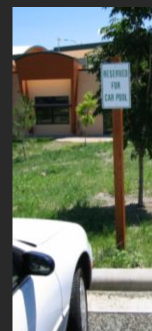


Light Shelf:

- reflects daylight onto ceiling plane on top
- Shades window on bottom for glare-free view

Site : Alternative Transportation





Bicycle Commuters

- Covered bike racks
- Showers

Auto Commuters

- Designated parking for carpools
- Hybrid vehicle for organization

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HIGH PLAINS ARCHITECTS

Water : Efficiency Measures

Native Planting

- Drought resistant
- Uses drip irrigation system
- Water use reduced by more than 50%

Waterless Urinal

- Name says it all

Microflush Composting Toilets

- 1 pint per flush
- Water trap prevents odors, vectors
- Saves 30,000 gallons per year

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HIGH PLAINS ARCHITECTS

Energy : Efficient Mechanical Systems

Evaporative Cooling

- 5x as efficient as refrigeration air conditioning
- Ideal in Montana's dry climate
- healthier: 100% outside air

Radiant Heating

- approximately 20% more efficient than air-based heating systems
- more comfortable—no drafts or heat stratification

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Energy : Renewable Sources

Photovoltaic Panels

- 9.9 kW system generates 53% of total electricity use (32% of total energy cost—natural gas & electricity)

Solar Hot Water Panels

- estimated to reduce total building energy usage 5-10% (not modeled)

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Daylighting: from the Exterior

Typical Light Shelf

Virtual Bays & Clerestory Monitors

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Daylighting: from the Interior

Office with daylight from Light Shelf

Gallery with daylight from Clerestory Monitor

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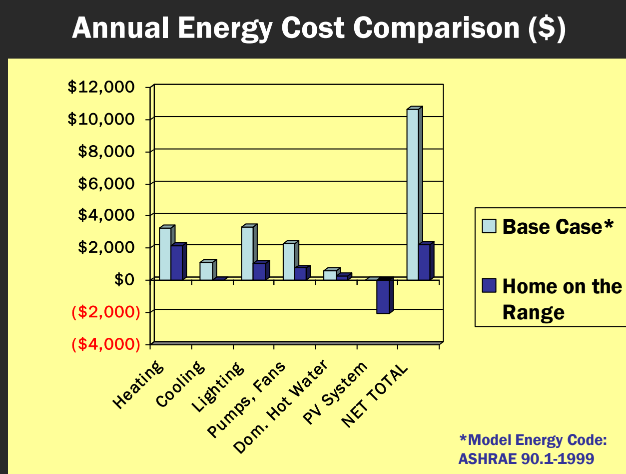
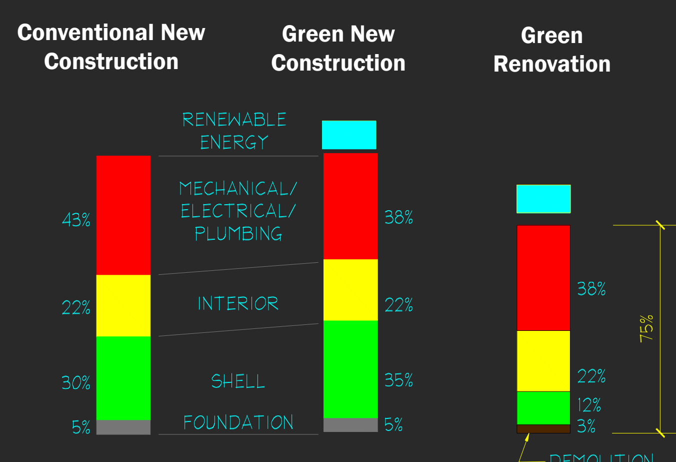
HIGH PLAINS ARCHITECTS

Energy Modeling: Post Construction



Green Building: shifting rather than increasing upfront costs



Green Building: Capital Costs

Conventional Approach (Estimates*)			Green Building Approach (HOTR Actual)	
Property	$ 182,500		$ 182,500	Property
Professional Services (10%)	$ 134,790		$ 122,000	Professional Services
Demolition	$ 70,500		$ 15,000	Deconstruction (partial)
New Construction	$ 1,156,700		$ 839,200	Renovation
-			$ 66,200	Alternative Energy Systems
Site	$ 191,200		$ 165,700	Site Improvements
-			$ 12,800	LEED-related costs & fees
TOTAL CAPITAL COSTS	**$1,735,690**		**$1,403,400**	**TOTAL CAPITAL COSTS**

***Estimates from 2006 RS Means Building Construction Cost Data based on 8,300 SF commercial office @ $135/SF w/ 1,200 SF basement @ $30/SF**

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HIGH PLAINS ARCHITECTS

Capital + Operating Costs*

	Baseline Office Building meeting Model Energy Code**	Home on the Range
TOTAL CAPITAL COSTS	**$1,735,190**	**$1,403,400**

$331,790 capital savings

Capital + 10 years of Operation Costs	$1,863,183	$1,429,813

$331,790 capital savings + $101,580 operational savings = $433,370

Capital + 20 years of Operation Costs	$2,051,903	$1,468,912

$331,790 capital savings + $251,201 operational savings = $582,991

Capital + 30 years of Operation Costs	$2,331,256	$1,526,787

$331,790 capital savings + $472,679 operational savings = $804,469

*** All figures assume annual 4% energy escalation rate**

****ASHRAE 90.1-1999 modeled using eQuest energy software**

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HIGH PLAINS ARCHITECTS

Home on the Range: LEED by the numbers

Sustainable Site

- Provides alternative transportation amenities for bicyclists, carpoolers, & a hybrid vehicle
- 100% of stormwater treated on-site
- Minimizes urban heat island effect

Water Efficiency

- 50% less irrigation water for landscaping
- 90% less wastewater
- 60% less potable water

Energy & Atmosphere

- 79% less energy used (by value)
- 52% of electricity generated on-site
- 100% of remaining electricity from wind sources for one year

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HIGH PLAINS ARCHITECTS

Home on the Range: LEED by the numbers

Materials & Resources

- 95% of existing building reused
- 92% of construction & demolition waste diverted from landfill (by weight)
- 16% of materials were salvaged (by value)
- 10% of materials have recycled content (by value)
- 23% of materials from sources within 500 miles (by value)
- 60% of wood from FSC certified forests

Indoor Environmental Quality

- 100% outside air used to cool building
- 100% of materials contain no urea formaldehyde
- 100% of regularly occupied rooms have high levels of daylight and views outside

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HIGH PLAINS ARCHITECTS

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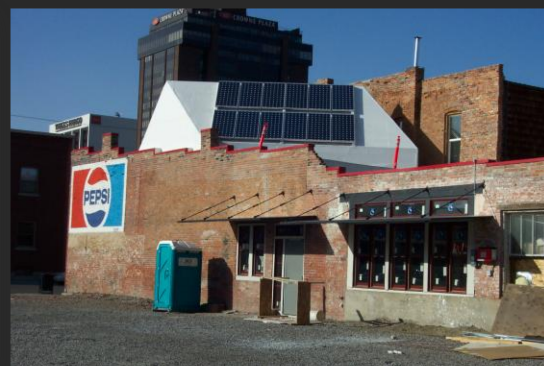
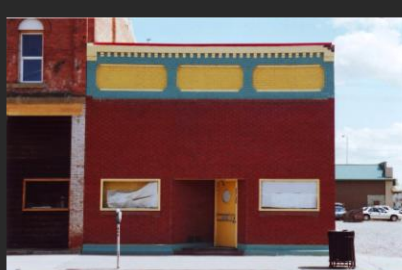
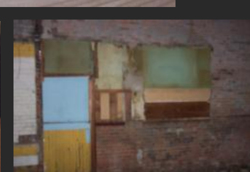
Klos Building Remodel



HIGH PLAINS
ARCHITECTS

Klos Building Remodel



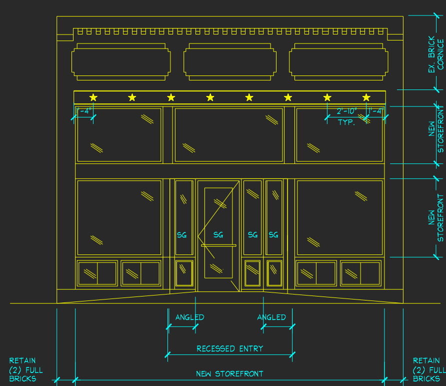


<u>Existing Klos Building:</u>
- 1893 construction
- Unfortunate mid-century façade change
- No floor
- But roof & wall are OK

Another unlikely LEED candidate

HIGH PLAINS
ARCHITECTS

Klos Building Remodel



Klos Building – proposed façade changes

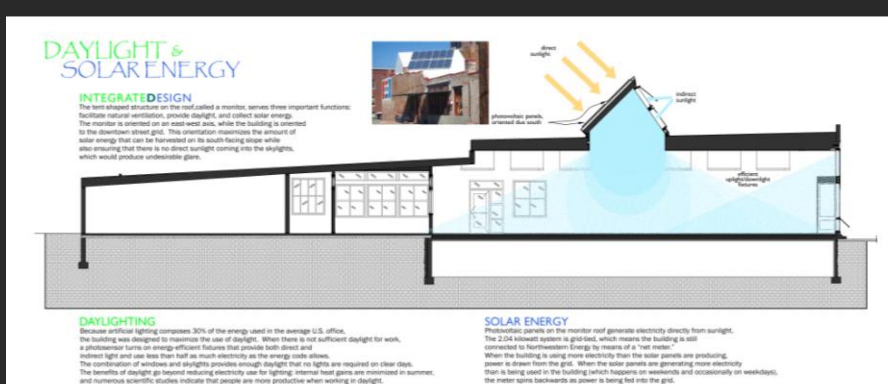
Klos Building Green Measures

1. Super-insulating attic, rigid insulation under drywall
2. Low-E glazing in windows
3. Advanced daylighting strategies
4. Natural ventilation
5. Radiant floor heating
6. Evaporative cooling
7. Rainwater collection
8. Photovoltaic panels
9. 100% fly ash & recycled glass concrete slab
10. Extensive salvaged doors, trim

Klos Building Remodel

Rooftop Monitor:

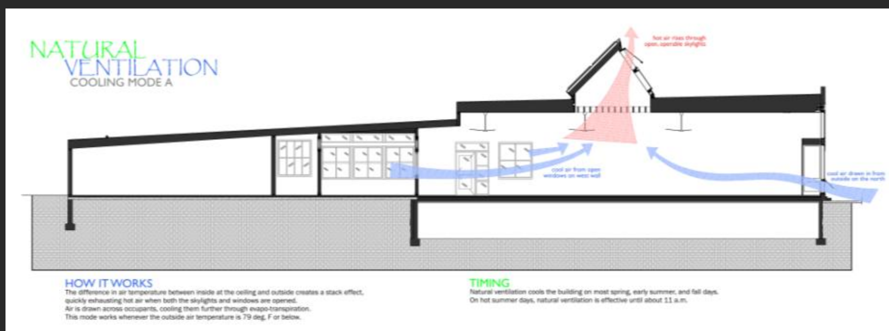
- Facilitates natural ventilation
- Provides north-facing daylight
- Mounting surface for 2.04 kW photovoltaic array



Klos Building Remodel

Cooling Mode A:

- Stack ventilation with monitor skylights and windows
- Completely passive
- Works all day in early summer and fall; works until approximately 11 am on hot summer days



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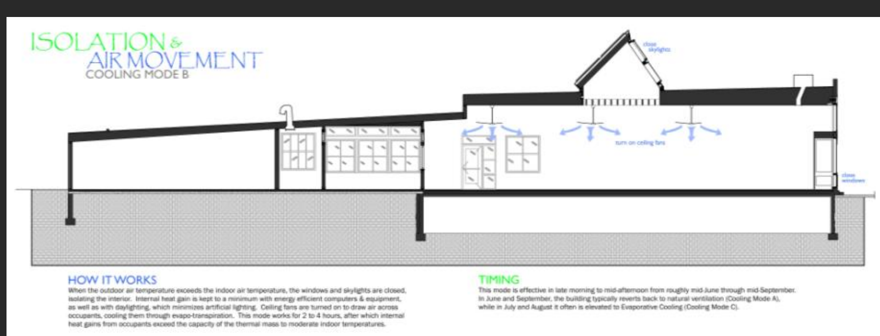
HIGH PLAINS ARCHITECTS

Klos Building Remodel

Cooling Mode B:

- Close windows & operable skylights in monitor
- Turn on ceiling fans
- Works for about 3-4 hours, then Cooling Mode A or Cooling Mode C, depending on outside temp.



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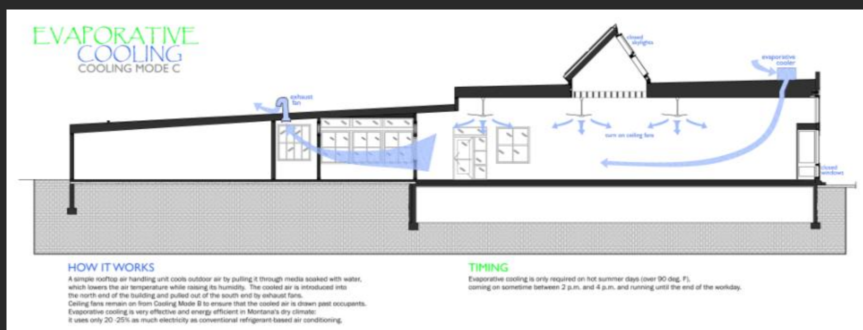
Klos Building Remodel

Cooling Mode C:

- Evaporative cooling
- Keep ceiling fans on, windows closed
- Rooftop unit dumps cool air in front, and exhaust fans pull it out at rear of office

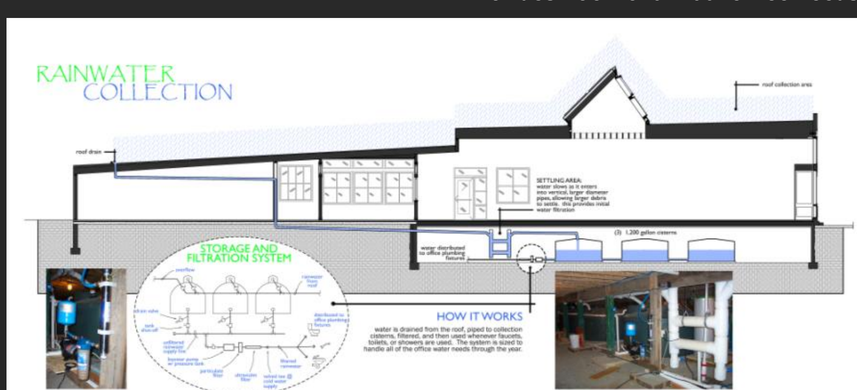


HIGH PLAINS ARCHITECTS

Klos Building Remodel

Rainwater Collection System:

- 3,000 sq. ft. roof collection area
- 3,600 gallon cistern storage
- Provides 100% of annual office needs



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HIGH PLAINS ARCHITECTS

Klos Building Remodel

Crawlspace with collection tanks, booster pump, particulate and UV filters.
Sediment catcher in foreground.

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HIGH PLAINS ARCHITECTS

Klos Building Remodel

Currently compiling LEED documentation.

Gold or Platinum certification is anticipated.

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HIGH PLAINS ARCHITECTS

Klos Building Remodel: LEED by the numbers

Sustainable Site

- Provides alternative transportation amenities for bicyclists, carpoolers, & a hybrid vehicle
- 100% of stormwater used on-site
- Development density & community connectivity

Water Efficiency

- 100% of water from rainwater

Energy & Atmosphere

- 66% less energy used than code (by value)
- 28% of electricity generated on-site
- 100% of remaining electricity from wind sources for one year

Klos Building Remodel: LEED by the numbers

Materials & Resources

- 95% of existing building reused
- 66% of construction & demolition waste diverted from landfill (by weight)
- 21% of materials were salvaged (by value)
- 11% of materials have recycled content (by value)
- 36% of materials from sources within 500 miles (by value)
- 6% of materials from rapidly renewable sources (by value)

Indoor Environmental Quality

- 100% outside air used to cool building
- 100% of materials contain no urea formaldehyde
- 100% of regularly occupied rooms have high levels of daylight and views outside

Swift Building Lofts

- Conversion of 1916 refrigerated warehouse into 9 loft apartments
- Seeking LEED for Homes Platinum certification

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HIGH PLAINS ARCHITECTS

Swift Building Lofts

Existing first floor

Green Building Measures

1. Superinsulate roof and walls
2. Low-E glazing in windows
3. Radiant floor heating
4. Radiant floor cooling
5. Dual flush toilets, 1.6 gpm showerheads
6. Rainwater collection
7. Solar hot water panels (120 SF of collector area)
8. Photovoltaic panels (4 kW array)
9. Extensive salvaged doors, trim
10. FSC certified wood interior framing

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HIGH PLAINS ARCHITECTS

Swift Building Lofts

33% reduction in Potable Water compared to code baseline

- 23% reduction due to fixture efficiency
- 10% reduction due to using rainwater and well water for toilet flushing

Costs & Benefits of Green Building

Cost Shifting

- Applying Integrated Design Process & End Use / Least Cost Planning
- No higher upfront cost

Life Cycle

- Using higher quality, more durable materials and higher efficiency mechanical equipment
- Higher upfront cost, but also higher value (ie. lower cost per year of product lifetime or total efficiency savings over life exceeds incremental upfront cost
- These types of investments may have much higher returns than stock market with lower risk

Costs & Benefits of Green Building

Reduced Risks

- Improving Indoor Environmental Quality with non-toxic, healthier materials and better ventilation
- Perhaps minor higher upfront costs, which are offset by reduced liability for sick building syndrome or employee sick time

Productivity

- Improving Indoor Environmental Quality with daylighting and views
- Potentially higher upfront costs, but savings through improved employee productivity or resident comfort are calculated to exceed all other financial benefits (reduced utilities, O&M, etc.) by more than 2x (Greg Kats, Capital E, 2003)

Costs & Benefits of Green Building

Internalizing Externalities

- Benefits are not directly realized by owner
- Big Picture, influenced by public policy
- Benefits to society include:
    1. Avoided environmental remediation costs (mine reclamation, Superfund toxic cleanups, loss of wildlife due to pollution)
    2. Avoided medical expenses (asthma, cancer, etc.)

HIGH PLAINS ARCHITECTS

Costs & Benefits of Green Building

Internalizing Externalities

- Benefits to society, continued:
  3. Avoided global climate change costs (levees, forest fires, drought relief, flood insurance, etc.)
  4. Avoided political and financial costs of securing foreign energy sources (eg. War in Iraq)

Energy & Water Relationship

Electricity use in California:

California consumes about 250 Billion kWh/yr

Up to 50 Billion kWh/yr is related to water

Thus, water-related energy use is about 20% of total electric consumption in California

Source: Southern California Edison

Energy & Water Relationship

How is Energy Used with Water?

1. Increase Water Quality

2. Increase Elevation or Pressure
   (potential energy)

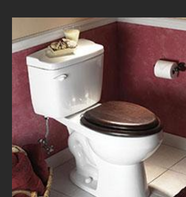
3. Increase Water Temperature

Energy for Water Treatment

Water treated by U.S. public water systems each day: 43 billion gallons Source: US EPA

Electricity to treat public water & sewage each day: 153,425 kilowatt-hours (kWh)
Source: US EPA

Thus, 3.56 watt-hours (Wh) are required for each gallon of water



3.5 gallons / flush

1.2 gallons / flush

= =

60 watt bulb

7 min. 30 sec.

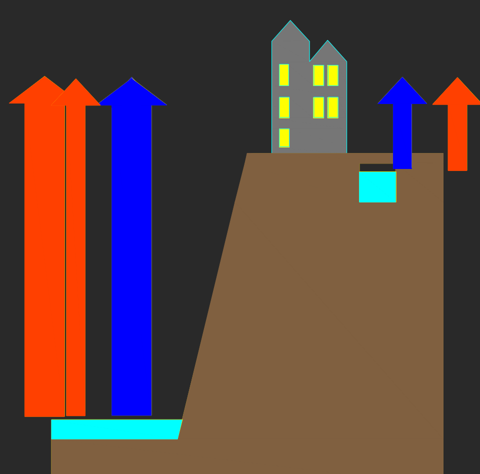
2 min. 45 sec.

Energy for Water Treatment

Strategies for reducing water treatment energy:

1. Use less water through efficiency & conservation
2. Match water quality to end use

Energy for Pumping



The greater the elevation difference, the more pump energy required

- Municipal
- Well

Strategies for reducing pumping water:

1. Use less water through efficiency & conservation
2. Use rainwater & greywater

Energy for Water Heating

Strategies for reducing water heating energy:

1. Use less hot water through efficiency & conservation
2. Use high efficiency water heaters and boilers (+90%)
3. Solar hot water panels

HIGH PLAINS ARCHITECTS