
LEED Benchmarking for Lightweight Structures
Malcolm Barr, MIEAust, LEED AP
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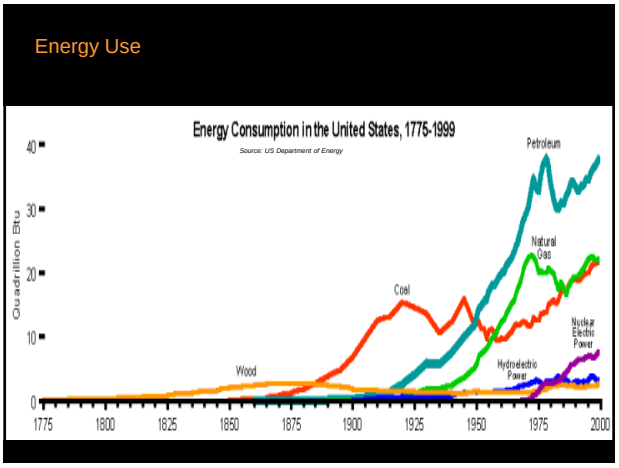
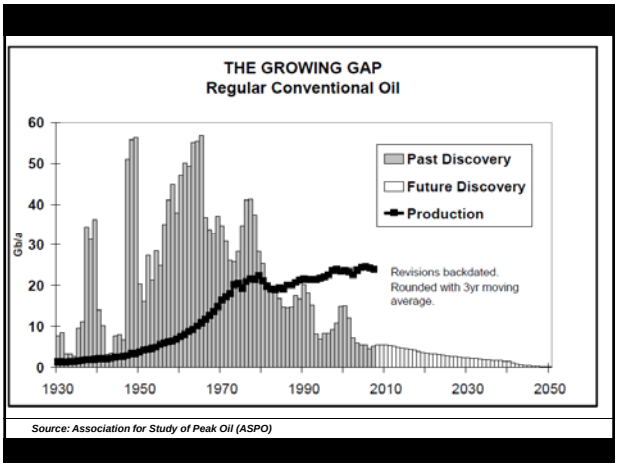
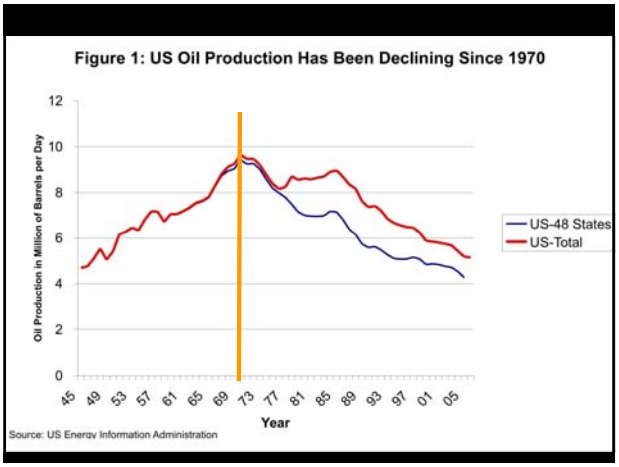
1928
climate change
2004
Upsala Glacier, Argentina

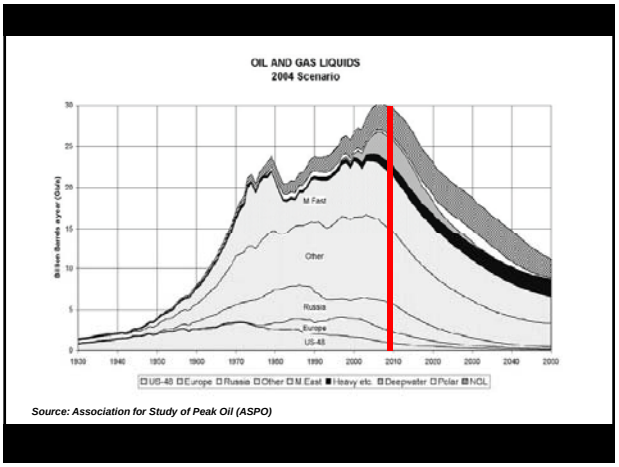

energy

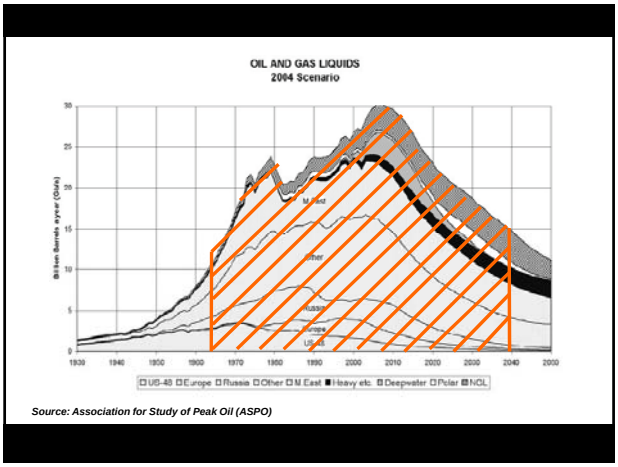

Energy Use
Energy Consumption in the United States, 1775-1999
Source: US Department of Energy
Quadrillion Btu
Petroleum
Natural Gas
Coal
Nuclear Electric Power
Hydroelectric Power
Wood
0
10
20
30
40
1775
1800
1825
1850
1875
1900
1925
1950
1975
2000


peak oil


THE GROWING GAP
Regular Conventional Oil
Gb/a
Past Discovery
Future Discovery
Production
Revisions backdated.
Rounded with 3yr moving
average.
0
10
20
30
40
50
60
1930
1950
1970
1990
2010
2030
2050
Source: Association for Study of Peak Oil (ASPO)







LEED® Green Building Rating System

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LEED

- USGBC formed 1993
- Pilot LEED program launched 1998
- Programs are voluntary, consensus-based and market driven
- Promotes whole-building approach by recognizing performance in five key areas:
  - Sustainable site development
  - Water savings
  - Energy efficiency
  - Materials selection
  - Indoor environmental quality

LEED-NC v3

- Version 3:
  - take advantage of new technologies & advancements in building science
  - prioritizing energy efficiency and CO_2 emission reduction
- Key advancements:
  - Harmonization
  - Regionalization
  - Modified credit weightings

Federal Building, S Francisco (completed 2006)

LEED NC – Credits

Sustainable Sites — **26 possible points**

☑	Prerequisite 1	Construction Activity Pollution Prevention
☐	Credit 1	Site Selection
☐	Credit 2	Development Density and Community Connectivity
☐	Credit 3	Brownfield Redevelopment
☐	Credit 4.1	Alternative Transportation—Public Transportation Access
☐	Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms
☐	Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles
☐	Credit 4.4	Alternative Transportation—Parking Capacity
☐	Credit 5.1	Site Development—Protect or Restore Habitat
☐	Credit 5.2	Site Development—Maximize Open Space
☐	Credit 6.1	Stormwater Design—Quantity Control
☐	Credit 6.2	Stormwater Design—Quality Control
☐	Credit 7.1	Heat Island Effect—Nonroof
☐	Credit 7.2	Heat Island Effect—Roof
☐	Credit 8	Light Pollution Reduction

LEED NC – Credits

Water Efficiency — **10 possible points**

☑	Prerequisite 1	Water Use Reduction
☐	Credit 1	Water Efficient Landscaping
☐	Credit 2	Innovative Wastewater Technologies
☐	Credit 3	Water Use Reduction

Energy and Atmosphere — **35 possible points**

☑	Prerequisite 1	Fundamental Commissioning of Building Energy Systems
☑	Prerequisite 2	Minimum Energy Performance
☑	Prerequisite 3	Fundamental Refrigerant Management
☐	Credit 1	Optimize Energy Performance
☐	Credit 2	On-site Renewable Energy
☐	Credit 3	Enhanced Commissioning
☐	Credit 4	Enhanced Refrigerant Management
☐	Credit 5	Measurement and Verification
☐	Credit 6	Green Power

LEED NC – Credits

Materials and Resources — **14 possible points**

☑	Prerequisite 1	Storage and Collection of Recyclables
☐	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors and Roof
☐	Credit 1.2	Building Reuse—Maintain Existing Interior Nonstructural Elements
☐	Credit 2	Construction Waste Management
☐	Credit 3	Materials Reuse
☐	Credit 4	Recycled Content
☐	Credit 5	Regional Materials
☐	Credit 6	Rapidly Renewable Materials
☐	Credit 7	Certified Wood

LEED NC – Credits

Indoor Environmental Quality — **15 possible points**

☑	Prerequisite 1	Minimum Indoor Air Quality Performance
☑	Prerequisite 2	Environmental Tobacco Smoke (ETS) Control
☐	Credit 1	Outdoor Air Delivery Monitoring
☐	Credit 2	Increased Ventilation
☐	Credit 3.1	Construction Indoor Air Quality Management Plan—During Construction
☐	Credit 3.2	Construction Indoor Air Quality Management Plan—Before Occupancy
☐	Credit 4.1	Low-Emitting Materials—Adhesives and Sealants
☐	Credit 4.2	Low-Emitting Materials—Paints and Coatings
☐	Credit 4.3	Low-Emitting Materials—Flooring Systems
☐	Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products
☐	Credit 5	Indoor Chemical and Pollutant Source Control
☐	Credit 6.1	Controllability of Systems—Lighting
☐	Credit 6.2	Controllability of Systems—Thermal Comfort
☐	Credit 7.1	Thermal Comfort—Design
☐	Credit 7.2	Thermal Comfort—Verification
☐	Credit 8.1	Daylight and Views—Daylight
☐	Credit 8.2	Daylight and Views—Views

LEED NC – Credits

Innovation in Design — **6 possible points**

☐	Credit 1	Innovation in Design
☐	Credit 2	LEED Accredited Professional

Regional Priority — **4 possible points**

☐	Credit 1	Regional Priority

LEED NC – Certification

	Pts
Sustainable Sites	26
Water Efficiency	10
Energy and Atmosphere	35
Materials and Resources	14
Indoor Environmental Quality	15
Innovation in Design	6
Regional Priority	4
Total	110

Certification Levels:

Certified	40 - 49 pts
Silver	50 - 59 pts
Gold	60 - 79 pts
Platinum	80 pts & above

Characteristics of Building Materials

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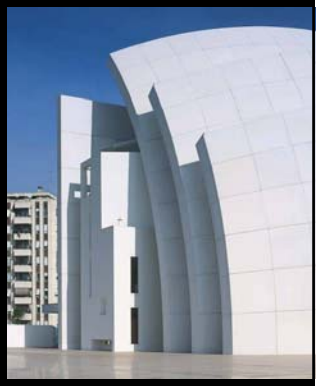
Concrete

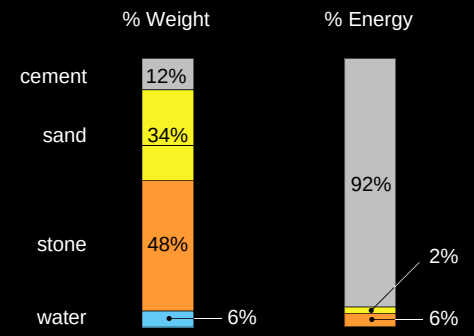
2nd most consumed material in the world, after water

7 billion m^3 of concrete poured in 2006 (China used 40%)



Jubilee Church, Tor Tre Teste, Rome, Richard Meiers

Embodied Energy in Concrete



Concrete's Sustainability Impact

- 1 ton Portland Cement generates between 0.8 to 1.0 ton CO_2
- High temperature + CO_2 is a by-product of calcination process
- Approx 8% of world man-made CO_2 production is from concrete (5% for cement)

Concrete's Advantages

- Concrete is made from local materials
- Concrete can be made with component of recycled waste or industrial byproducts (fly ash, slag, glass, etc)
- Concrete's high thermal mass moderates temperature swings → significant energy savings

K2 Sustainable Housing, Melbourne

Steel

Steel production in 2008 was 1330 million tonnes

Steel's Sustainability Impact

CMU – School of Computer Science Complex, Pittsburgh, USA

- 1.70 tonnes of CO_2 produced per tonne of steel
- Making steel very energy intensive
- Susceptible to corrosion
- Recycling steel requires 1/3 of energy of new steel,

& Reduces CO_2 emissions by up to 80% of new steel

Steel's Advantages

- Facilitates long spans, = flexibility & adaptability
- High strength-to-weight ratio reduces foundation requirements
- Can be salvaged for reuse
- Highly recycled and can continue to be recycled indefinitely

Khalifa Stadium, Doha, Qatar

Glass

Positive Impacts:

- 100% fully recyclable
- Reasonable EE.

Negative Impacts:

- 1 tonne of glass produces b/w 500 to 900 kg of CO_2
- Low insulation for ordinary glass

Scope for Improvement:

- Improve recycling (coatings)
- Increase re-use

Woven Fabrics

Advantages:

- Sculptural forms possible
- Lightweight, fabric only 1kg/m^2
- Low maintenance
- Translucency of fabric
- Large spans possible
- Potential to demount or relocate
- Cost for simple and large canopies, can be comparable to conventional roofing.

Woven Fabrics

Disadvantages:

- Low thermal insulation
- Acoustic performance (sound reflectance, noise break-in)
- Susceptibility to vandalism, if accessible
- For small or complex structures, high $$

ETFE

Positive Impacts:

- Fully recyclable
- Low EE

Negative Impacts:

- Rain noise,
- Noise break-in

Lightweight Structures - LEED Opportunities

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Shading

To reduce heat islands to minimise impacts on microclimates and human and wildlife habitats

LEED Credit: SS 7.1

Opportunity:

- Provide shade from architectural devices or structures that have solar reflectance index (SRI) of at least 29.

Daylighting

Fundamental component of built environment.

LEED Credit: IEQ 8.1

Opportunity:

- Increase solar gain in winter & decrease in summer
- Diffused light into interior spaces
- Reduce lighting required.
- Improve productivity through access to views.

Optimising Energy Performance

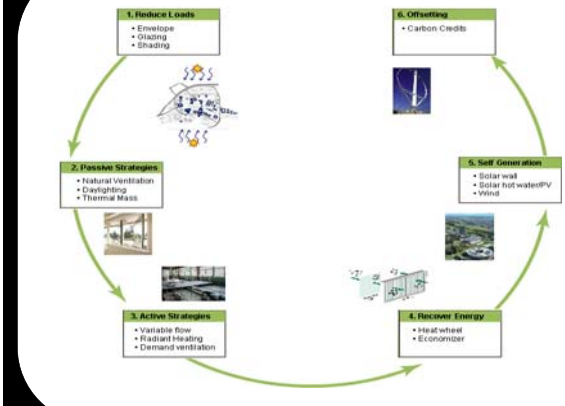
One of key aims of LEED is to reduce environmental and economic impacts associated with excessive energy use.

There are up to 19 points available.

LEED Credit: EA 1

Opportunity:

- Solar shading
- Provide semi-conditioned spaces
- Assisting project improve energy performance



Lightweight Structures – Other Sustainability Challenges

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Increase Design Life

- Improve design life by use of new base materials and/or protective coating systems

Improve Recycling

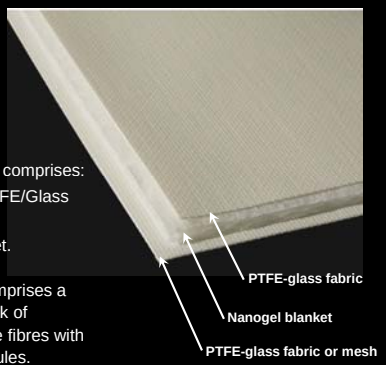
- Design systems with clearly marked components for easy identification & removal
- Separate components from each other & from structure
- Design connections so material can be easily removed for reuse
- Avoid toxic materials / treatments that may inhibit future re-use or recycling of material.

Increase Insulation Levels

Tensotherm – by Birdair

Tensotherm fabric system comprises:
outer and inner skin of PTFE/Glass fabrics
a core of insulating blanket.

The insulating blanket comprises a heat bonded loose network of polyethylene polyurethane fibres with dispersed nanogel® granules.



Final Thoughts

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Future Challenges

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