General Session

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General Session

- National Energy Situation and Prognosis
- The Future of the Built Environment
- Basics of Energy Management
- Energy Efficiency
- Green Buildings
- Renewables
National Energy Situation
U.S. Energy Flows 2007 (Quads)

Source: DOE/EIA 2008
US Energy Use (Quads)

Total Energy up 18% by 2030

World-wide demand yielded to the pressures of high prices and the deteriorating global economy.
Can We Affect our Addiction?
Actual Production
2002 – 28.10 Gb
2003 – 29.05 Gb
2004 – 30.34 Gb
2005 – 30.86 Gb
2006 – 30.86 Gb
2007 – 30.82 Gb
2008 – 31.19 Gb
2009 – 30.24 Gb
Illinios Natural Gas Prices

Source: DOE/EIA 2009
Significant investment needed to offset declines

US Natural Gas Production History Indicates 32% 2006E Decline Rate

Production Decline Rate of Base:

17% 17% 16% 18% 19% 19% 20% 21% 23% 23% 25% 24% 27% 28% 29% 30% 32%

Utilizes Data Supplied by IHS Energy; Copyright IHS Energy
Chart Prepared by and Property of EOG Resources, Inc.; Copyright 2006
Unconventional Gas Production

**NATURAL GAS IN NORTH AMERICA – SUPPLY AND DEMAND**

- Rising demand for gas
- Imported liquefied natural gas (LNG)
- Gas from Arctic
- Coal bed methane
- Tight gas
- Gas from deepwater sources
- Gas from conventional sources

Demand for natural gas in North America and sources of gas supply. Source: CRA International
Horizontal Wells to Fracture Shale
Historical Average Weekly Coal Commodity Spot Prices (Dollars per Short Ton)

Key to Coal Commodities by Region:

- **Central Appalachia:** Big Sandy/Kanawha 12,500 Btu, 1.2 lb SO2/mmBtu
- **Northern Appalachia:** Pittsburgh Seam 13,000 Btu, <3.0 lb SO2/mmBtu
- **Illinois Basin:** 11,800 Btu, 5.0 lb SO2/mmBtu
- **Powder River Basin:** 8,800 Btu, 0.8 lb SO2/mmBtu
- **Uinta Basin in Colo.:** 11,700 Btu, 0.8 lb SO2/mmBtu
The rise in fossil energy prices was driven by structural changes in the world economy that produced rapidly increasing demand at the same time rising costs of production.

- We have a dip now, but higher prices will return once the economy recovers.
- Electrical restructuring will result in continued price increases (and you haven’t see anything yet.)
Where are We Headed?
Impact of Buildings

• Buildings in the United States consume:
  • 71% of electricity production.
  • 39% of total energy flows.
  • 17% of total US freshwater flows (12% of potable).
  • 25% of the harvested wood.

• Buildings in the United States generate:
  • 38% of CO2 emissions.
  • 50% of the CFC emissions.
  • 136 million tons of C&D waste (40% of landfill material -- 2.8 lbs/person/day).
Energy Efficiency

- The cost of saving energy is going down while the price of has been energy is going up. This is just a temporary pause.
- Efficiency is the cleanest, cheapest, safest, and most secure source energy we have.
- These savings from energy efficiency to date have not yet come close to tapping the full potential for savings.
AIA 2030 Position Statement

- Promote sustainable design including resource conservation to achieve a minimum 50 percent reduction from the current level of consumption of fossil fuels used to construct and operate new and renovated buildings by the year 2010, and promote further reductions of remaining fossil fuel consumption by 10 percent or more in each of the following five years.

Source: AIA November 2005
Providing tools by 2020 to enable the building community to produce market-viable NZEBs by 2030.

NZEB means the building produces as much energy as it uses when measured at the site.
ASHRAE/IESNA Actions

- **Advanced Energy Design Guides:**
  - 30%, 50%, 70%--Net Zero Energy
  - Small Buildings (20-50ksf)
  - Small Office, Small Retail, K-12 Schools, Warehouses, Highway Lodging, Small Healthcare, and Existing Buildings.

- **Schedule:**
  - Complete 50% guides by 2011.
  - Complete 70% guides by 2015 to included “net-zero” guidance.

*Tools in place by 2020 and market viable NZEBs by 2030. Std 90.1–2031 Net Zero Energy.*
ASHRAE AEDGs

Download free: http://www.ashrae.org/aedg
ASHRAE Path to Net Zero Energy

Energy Use Targets
For Code-Intended Standards

Targets in kbtu/square foot/year
Energy Opportunities

- Potential energy savings ranged from a high of 100% to a low of 3% for existing buildings and between 96% and 12% for new designs (the high end incorporates renewables).
- Data from 220 existing buildings show:
  - 29% energy savings.
  - 28% energy cost savings.
  - Typical savings of $45k per year.
- Data from 37 new building designs show:
  - 50% energy savings.
  - 47% energy cost savings.
  - Typical savings of $53k per year.

Typical client uses $2.02/sf and can save $0.61/sf.
Opportunity for Change

- Each year in the United States, we tear down approximately 1.75 billion square feet of buildings, renovate 5 billion square feet, and build new another 5 billion square feet.
- During the next 30 years, some 50 billion square feet will be torn down, some 150 billion will be renovated, and another 150 billion will be built new.
- By 2030, three-quarters of the built environment will be either new or renovated.

Why Build Energy Efficient?

- Reduce operating costs of buildings.
- Stabilize atmospheric carbon & reduce global climate change impacts.
- Improve the quality of life in our buildings and communities.
- Reduce demand for fossil fuels.
- Meet increasingly stringent codes, qualify for rebates, and meet LEED criteria.
The Basics of Energy Management
The Benefits of Energy Management

- Reduces energy at your facility:
  - Typical buildings can save 10 to 20% with best practices and up to 30% with major mods.

- Reduces environmental impact of energy usage:
  - Energy efficiency is by far the most cost effective solution.
  - Focus on energy sources that yield the most savings.

- Reduces the impacts of future rate increases:
  - The less energy you use, the lower your total cost increases will be.
  - Energy efficiency costs <$500/kW while new sources cost $3,000 to $10,000 per kW.
Energy Management

- How to get more efficient and reduce costs:
  - Use a systematic approach.
  - Plan for continuous improvement.
  - Your program should be integrated into how you do business.
  - Apply the level of effort appropriate to your organization’s energy costs and usage (10 percent of your goal/year).

*If you don’t know where you are going, it is awfully hard to get there.*  
Yogi Berra
Energy Management Programs are Useful Because:

- Energy costs are increasing and becoming a larger percentage of operating costs.
- A systematic approach insures that all opportunities are considered.
- Continual improvement insure new methods and technologies are incorporated into an existing program.
- Energy can be managed and many operations are not capitalizing effectively on this opportunity.
Level of Program Effort

- Should be appropriate to your level of energy usage & cost and your opportunities & risks.
- Opportunity to reduce costs is typically 10 to 20% over 5 years. (2 to 4 percent per year).
- Program administration costs should be about 1 to 2 percent of annual energy costs.
- For a $1 million annual use, this could justify spending $20,000 to $40,000 to plan and administer a five year program.
Typical Approach

- Gather Data
- Analyze Data
- Quantify Opportunities
- Select Projects
- Provide Justification
- Gain Approval
- Implement Projects
- Project Validation

Communications
Planning

Set Goals
Awareness
Performance Tracking
Energy Management Plan

1. Management Approach
2. Facility Profile
3. Energy Use Profile
4. Best Practices
5. Project Prioritization
6. Project Management
7. Key Performance Indicators
8. Continual Improvement
Green Buildings & LEED
The Triple Bottom Line.
- Reduced Environmental Impact.
- Peak Efficiency.
- Improved Capitalization Rates.
- Increased Marketability.
- Higher Lease Rates.
- Improved Productivity.
- Reduced Absenteeism.
- Build Green.
- Everyone Profits.
Green Buildings Can Reduce...

Improved Bottom Line.

- 30–70% Energy Savings
- Verified Performance
- Enhanced Productivity
- Reduced Liability & Improved Risk Management
- Increased Value

Increased Value
Improved Bottom Line.

- Reduced Absenteeism
- Improved Employee Morale
- Enhanced Recruitment
- Productivity
- Reduced Liability & Improved Risk Management
- Increased Value
- 30-70% Energy Savings
- Verified Performance
- Improved Bottom Line.
Average Productivity Gains

High-performance lighting enhances productivity by 6.7%.

Individual temperature control enhances productivity by 3.6%.
Increased Productivity.

- **SCHOOLS**: 20% Better Test Performance
- **HOSPITALS**: Earlier Discharge
- **FACTORIES**: Increased Production
- **OFFICES**: 2-16% Productivity Increase
- **RETAIL**: Increase in Sales per Square Foot
What is green building?
Design and construction practices that meet specified standards, resolving much of the negative impact of buildings on their occupants and on the environment.
The Leadership in Energy and Environmental Design (LEED) Green Building Rating System®, developed and managed by the USGBC, is the most widely used rating system in North America.

Green Globes, formed by groups in Canada and the United States as an alternative to LEED, emphasizes ease of use, low cost, and user education through its web-based application.

National Green Building Standard for residential construction, including both new and renovated single-family to high-rise residential buildings – ICC700. Approved 1/29/09. Developed by NAHB & ICC.
Levels of LEED Ratings

Green Buildings worldwide are certified with a voluntary, consensus-based rating system. USGBC has four levels of LEED.
Taking LEED to the Next Level

- Bio-regionally Weighted Credits
- LCA as Basis for LEED Credits
- Smart Credits
- Improved Accounting for:
  - Energy
  - Ecological Sites
  - Transport Implications
  - IEQ
  - Health

LEED 2009
LEED for New Construction Buildings
Distribution by Building Type
as of 09/06

- K-12 Education: 166
- Multi-Unit Residential: 148
- Commercial Office: 391
- Higher Education: 199
- Public Order & Safety: 142
- Multi-Use: 1074
- Not Classified: 101
- Library: 91
- Industrial: 91
- Laboratory: 64
- Financial & Communications: 7
- Special Needs Housing: 92
- Recreation: 42
- Campus: 24
- Transportation: 18
- Military Base: 20
- Interpretive Center: 86
- Stadium Arena: 3
- Assembly: 37
- Animal Care: 8
- Hotel/Resort: 12
- Daycare: 12
- Community: 17
- Park: 8

Buildings Distribution by Building Type

- 300+
- 100-299
- 50-99
- 3-49
Market Sectors

- Public Facilities: 30%
- Education: 24%
- Commercial: 20%
- Health Care: 11%
- R&D: 5%
- Residential/Hotel: 5%
- Industrial: 5%
- Transportation: 1%
Additional constructions costs for LEED-certified buildings

Average for offices and schools, based on 40 buildings

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<tr>
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Results of the California Study:
Average Bottom Line Savings

GREEN IMPROVEMENTS PAY FOR THEMSELVES IN 3 YEARS

(ANNUAL RETURN ON INVESTMENT IS 25–40%)
Renewable Energy for the Public Sector
Energy Futures

- Over 80 per cent of the world's primary energy supply is currently derived from fossil fuels.
- Concerns around energy security, climate change, and price volatility and inflation are driving the search for cheaper and more environmentally friendly alternatives.
- It is only recently that technological advances and reduced production costs have meant renewables can fulfill this need.
What the future must look like:

Renewable energy
Some Sobering Thoughts

The transition to new renewable energy sources is unavoidable, but there are some issues to consider:

- Scale of the shift.
- Energy density (Btu/lb).
- Power density (Watts/ft²).
- Intermittency.
- Geographical Distribution.

### Energy Density
- Coal – 12–15 kBtu/lb
- Oil – 19 kBtu/lb
- Biomass – 8–9 kBtu/lb

### Power Density
- Fossil – 10 to 100 W/ft²
- Biomass – <0.1 W/ft²
- PV – 2 W/ft²
- Wind/Hydro – <1 W/ft²

For the first half of 2008, renewable was over 10%

- Solar/PV grew 11% (36% cap)
- Wind grew 21% (43% cap)
- Biofuels grew 28%
- Coal fell 0.6%
- Natural Gas grew 1%
- Petroleum fell 6.1%
- Electricity fell 1.1%

Total = 101.545 Quadrillion Btu

Total = 6.813 Quadrillion Btu
Energy which comes from sources that are regenerative and virtually inexhaustible

Several types available, including:

- Wind
- Solar Photovoltaic and Thermal
- Biomass (Plant materials)
- Hydrokinetic (Hydroelectric, Run of River, Wave, Tidal)
- Geothermal (Heat from the ground)
Why renewable energy?

- Sustainability
- Climate change
- Peak oil
- Grid security
- Good will
- Efficiency important, but not enough.

In one minute, the sun provides enough energy to supply the world's energy needs for one year. In one day, it provides more energy than the world's population could consume in 27 years.
Growth in US Wind Capacity
Types

- Horizontal axis most common.
- Vertical axis:
  - Increasing in popularity, but have lower efficiencies.
  - Rooftop potential.
Illinois is ranked 16th in wind energy
Vestas NM82 1,650 kW
This turbine could generate power for about 475 homes at a good wind site. It is among the largest turbines available today. Installed cost is about $1,600,000.

Zond Z-40-FS 500 kW
This turbine could produce electricity for about 150 homes at a good wind site. Turbines in this size range were cutting edge technology in the mid-1990s. Installed cost is about $500,000.

Bergey Excel 10kW
At a good wind site, this turbine could generate enough electricity for one average household. Installed cost is about $35,000.
Wind Availability

- The power contained in the wind is based on the cube of the speed.
- Small changes in wind speed have great changes in power.
- Twice as much power at 13 mph than at 10 mph and eight times as much at 20 mph.
Costs

- $/kW decreases with higher capacity.
- Small turbines less than 100 kW typically cost $3,000 to $5,000 per kW.
- Large turbines:
  - Typically cost $1,000 to $3,000 per kW.
  - Utility grade 1 MW and higher - $1,000/kW
- Maintenance is about 1.5% per year of original cost or $0.01 per kWh.
Solar Photovoltaic Description

- Photovoltaic cells convert sunlight to electricity.
- Less economical than wind in Illinois.
Solar Availability

- Solar resources:
  - Better resources outside northeast of state.

- Exposure:
  - Panels should face south.
  - Tilt angle equal to latitude plus 10 degrees (Illinois latitudes - 37 to 42 degrees).
Costs

- Cost per watt decreases with capacity.
- Typical range: $8 to $10 per watt:
  - Can be as low as $5/watt for the collectors.
  - Thin film costs less, but is less efficient.
  - New technology may be as low as $1.70/watt.
- Total installed costs:
  - $8-12 thousand/kW
Other issues

- Space Required:
  - For a pitched roof – about 100sf/kW
  - For a flat roof – about 200sf/kW

- A typical system should generate about 1,200-1,300 kWh/kW of installed capacity.

- Payback is 15-30 years depending on incentives and upfront costs.
Advances

- Increased efficiency:
  - Recent breakthroughs reach 40%
  - Current cells around 8-19%
- Building integrated PV.
- Possible decrease in manufacturing cost.
Solar PV Production

Source: Energy Information Administration (EIA),
Photovoltaics Like Newsprint

- As opposed to using slow and expensive high-vacuum based thin-film deposition processes, a proprietary ink allows simpler and higher-yield printing for depositing the solar cell's semiconductor.
- A highly conductive, low-cost foil as a substrate avoids the need to separately deposit an expensive bottom electrode layer (as required for a non-conductive substrate such as glass).
- Uses high-yield continuous roll-to-roll processing.
- Achieves a lower-cost, high-performance top electrode.
- Cells are assembled by individually matching electrical characteristics.
- Panels are high-power, high-current with a lower balance-of-system cost.

Nanosolar SolarPly™
Solar Thermal Description

- Solar thermal uses solar collectors to heat water.
- More economical than PV.
- Return on investment can be great.
- Used for:
  - Service hot water
  - Pools
  - Space heating:
    - Forced air
    - Radiant hot water
Service
Hot Water System
Costs

- Typical system $100 to $150/square foot (costs are for total system).

- Examples:
  - Residential system - $4,200 for 48 sf (80 gal)
  - $6,100 for 96 sf (120 gal)
  - Large laundromat - $150,000 for 1,440 sf
Renewable Energy Funding

- Grants from the Illinois Clean Energy Community Foundation.
- Grants from state renewable energy programs.
- Tax incentives for those who pay taxes.
We have entered interesting times.

Enhancing energy efficiency in existing buildings and utility systems is an imperative.

New building and utility system designs have to be profoundly more efficient.

This is not going to go away. The current dip in oil prices is only a blip. We can’t punch enough holes in the ground to be “independent”.

Energy management presents a sound approach to deal holistically with the issues.
Illinois Smart Energy Design Assistance Center

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1-800-214-7954