The Challenge of Energy Efficiency

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The Challenge Ahead

• The Over-arching Drivers
  ▫ Fossil Fuel Issues
    • — Economic, Environmental, Social Impacts
  ▫ Climate Change
• Meeting the Challenge
  • — with efficiency and energy management
• The Great Transition
  • — to renewable energy
Fossil Fuels

- Main Stay Energy Source (83% of US consumption)
- Increasing Demand, Depleting Supply globally – affordability, availability concerns
- Continued Dependence on Foreign Sources (~30%)
- Accumulating Environmental Impacts – CO$_2$
- Disproportionate Use compared to population & supply sustainability, security concerns
Total Energy up 14% by 2035

- Less steep increase than last 25yrs, due to efficiency, structure US economy, economic collapse in 2008.
Total Energy up 14% by 2035

Key Factors for Future of Markets:
- Pace of economic recovery
- Willing investment for plants, exploration, production
- Future Legislation on Carbon and Environment
- Renewables and Natural Gas may grow at larger rates
US Primary Energy Flows 2009

Source: US EIA 2010
Buildings use 39 Quads, ~40% of US energy demand.
US Primary Energy Flows 2009

- Use pattern changes
- Sources and sinks => options
  - substitutions
  - interactions – ripple effects

Source: US EIA 2010
• Sharp increase since 2002, had been steady for 15 yrs
• Demand exceeding supply, eating into reserves
• Price dropped in 2008 w/ economy collapse

Source: DOE/EIA Nov 2010
Actual Crude Production

2003 – 69.4 Mb/day
2004 – 72.5 Mb/day
2005 – 73.7 Mb/day
2006 – 73.4 Mb/day
2007 – 73.0 Mb/day
2008 – 73.4 Mb/day
2009 – 72.3 Mb/day
2010 – 73.4 Mb/day

Source: USDOE 2010

• Apparent conventional oil peak 2005 – world wide
• How it plays out to be seen, not all cards known
• Peak => supply half gone
• Domestic peak in 1970.
Oil well decline rate 5%/yr
Current short fall made up with natural gas liquids and unconventional oil
Need 5 more Saudi Arabias by 2035 to maintain current levels
Unconventional Oil - at a cost (economic and environmental)

• Deep and Ultra-deep.
  ▫ We’re at the technological limits for now – 5 miles
  ▫ Total recoverable deep water resources are ~89 GB. (3yrs)

• Off to the wild places.
  ▫ Polar oil ~52 GB. (2yrs)
  ▫ Heavy (incl. tar sands & shale) ~226 GB. (7yrs)

• Unconventional sources
  ▫ More expensive,
  ▫ More difficult to find,
  ▫ More environmentally hazardous

BP’s Deepwater Horizon drilling rig explosion and blowout at Macondo Well in Gulf of Mexico, April 2010
Source: http://cgvi.uscg.mil/media/main.php?g2_itemId=836285
- Impressive rise since domestic production peak 1973
- Drop in 2008 w/ subprime mortgage crisis, back failure, sock market crash
- Prices expected to rebound
- Conventional Resources depleting rapidly.
- Decline rate 30%/yr.
US Natural Gas Production

- Decline in conventional sources leads to expanding unconventional
- Limited imports of NG are mostly from Canada
U.S. Unconventional Natural Gas Resources

- **Tight Gas Sands**
- **Gas Shales**
- **CBM**
Horizontal Wells to Fracture Shale

- 4-5 thousand vertical feet
- 1 mile horizontally
- Blast high pressure water to fracture rock, release gas
- Process technically challenging, expensive, with environmental risks
Natural Gas - A Fracking Mess

- Roughly 90% gas wells in the U.S. use hydraulic fracturing.
- The new gas play is not without risks.
- Significant water and chemicals used.
- NY State has a moratorium on fracking – concerns of aquifer contamination.
- USEPA re-examining the health risks with study due out in 2012.
- Potential game changer ~ 100 yrs supply

Photo © Heather Rousseau / Circle of Blue
World-wide Potential Coal Production

- Coal production expected to peak domestically and globally ~2030.
The Fossil Bottom Line

- The step change increase in fossil energy prices driven by structural changes in the world economy (growing population, increased living standards) that produced rapidly increasing demand at the same time with rising costs of production (from depleting conventional sources).
- Current pause in cost due to recession.
- Price escalation and volatility is a real and present danger. It will worsen as world economy recovers. Availability is problematic.
- Electrical restructuring will likely result in electrical price increases (20-50% elsewhere.)
A Nuclear Renaissance?

- Nuclear power provides 20% of our electricity.
- Constant proportion from
  - up-rating existing plants (more kW capacity)
  - recommissioning one shutdown plant
  - extending licenses (from 20yr to 50-80yrs)

- In US:
  1 plant under construction
  26 reactor applications.

- Around the world:
  50 reactors under construction
  130 planned for next 10 years
• Levelized cost for asset (plant), fuel, production of electricity
• Currently numerous options less costly than nuclear
• Efficiency the run away favorite
The Nuclear Bottom Line

- US will probably build six reactors:
  - EPAct 2005 provides assistance to 6 GW of new plants.
    - Loan guarantees, insurance against delays, and production tax credits ($18 Billion pot).
    - DOE loan guidance pending.
- Industry pushing for nukes to be part of Renewable Portfolio Standard programs – since carbon free.
- Environmental & Social issues remain – waste disposal, fuel security, no free lunch with energy.
The Climate Connection

- Burning Fossil Fuels releases CO\(_2\) which traps heat and warms the planet
- To avoid the most severe outcomes (unrecoverable sea level rise, extinctions), Temperature increase < 2\(^\circ\)C/3.5\(^\circ\)F relative to pre-industrial levels (about 1.1\(^\circ\)C/2\(^\circ\)F above present levels).
  CO\(_2\) Concentration ~ 400-450 ppm
- Emissions globally down 60% by 2050. (Industrialized countries down 80%, 2%/yr 2011-2050)
• Earth’s average temperature is rising.
• Less rise in Southern hemisphere – ocean absorbs heat
CO2 Concentrations are dramatic
Illinois’ Climate Migrates South

Changes in average summer “heat index”—a measure of how hot it actually feels based on a specific combination of temperature and humidity—could strongly affect Midwesterners’ quality of life in the future. For example, the red outlines track what summers in Illinois could feel like over the course of the century under the higher-emissions scenario; the yellow outlines track what summers could feel like under the lower-emissions scenario.
Climate Change is Here

- Already enough CO$_2$ in the atmosphere to continue the warming trend for about a 1000 years.
- We must reverse our emission trends starting now or face the worst of the expectations.
- Acting now is much cheaper than acting later.
- Yes, it will cost and it will require some changes in lifestyle, but we can get half to needed GHG emission reductions with a positive return on investment with energy efficiency.
- Denial is comforting, but it doesn’t change the facts.
The Midwest GHG Reduction Accord

Main recommendations (May 2010):
- Would prefer a federal system of cap and trade (American Power Act of 2010).
- Regional Cap & Trade Program:
  - Everyone gets involved and has accountability:
    - Electricity generation and imports to the region.
    - Industrial combustion sources.
    - Residential, Commercial, and Industrial Building fuels.
    - Transportation fuels.
    - Biofuels and small electrical generators exempt.
- GHG Reduction targets (2005 baseline):
  - 20% by 2020
  - 80% by 2050
Meeting the Challenges

- Challenges – Affordability, Availability, Sustainability, and Security
- Energy Efficiency – A big piece of the answer
- Energy Management - The necessary focus and follow through
The Public Sector

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<th>Category</th>
<th>Percent</th>
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<td>Local Government</td>
<td>3.8%</td>
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<tr>
<td>K-12 Schools</td>
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<td>Community Colleges</td>
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<td>Public Universities</td>
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<tr>
<td>State Buildings</td>
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<tr>
<td>Street Lighting</td>
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<td><strong>61%</strong></td>
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<tr>
<td><strong>Resid.</strong></td>
<td><strong>26%</strong></td>
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<tr>
<td><strong>Public</strong></td>
<td><strong>7%</strong></td>
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Untapped Energy Efficiency Opportunities

- Can’t build our way out
- Can’t wait for system failure
- Need to replace working systems w/ more efficient technology
  - hvac, envelope, lights, appliances
- Need to expand beyond lighting (80% current retrofits)
Why Increase Energy Efficiency

- Reduce operating costs.
- Stabilize atmospheric carbon & reduce global climate change impacts.
- Improve the quality of life in our buildings and communities.
- Enhance economic development.
- Meet increasingly stringent codes, qualify for rebates, and meet sustainable design criteria such as LEED®.
Energy Efficiency

• An issue that is here to stay.
• Must be become a permanent way of doing business.
• Higher expectations are placed on buildings in the public sector and we must accept a leadership role in society.
• Efficiency is the cleanest, safest, cheapest, and more secure source energy we have.
ENERGY STAR Guidelines For Energy Management

A Continual Improvement Process!
Commit by

Developing a Vision of Efficiency

• Define what energy efficient operations means to you.
  ▫ Review Motivation (economic, environmental, social)
  ▫ Recognize Challenges (cash flow, awareness, culture)
  ▫ Articulate Aspirational goal
    (e.g. carbon neutral, best in class, percent execution of best practices or cost-effective practices, do fair share for climate change, stay afloat)

• Vision must be sustainable and remain a priority over time.

• Rather than going off in a dozen different directions, ensure your organization is unified around one vision and one set of goals.

VISION ➔ GOALS ➔ ACTION
From Vision to Goals

- Breaking the vision down to goals helps clarify what you need to measure.
  (e.g. Energy Use Intensity, Carbon Footprint, Debt Reduction.)
- Backcast intermediate steps
- Set specific goals and establish metrics to measure progress.
- These goals will drive actions and create opportunities to celebrate successes as goals are achieved.
- Organizations need to see progress and not get bogged down in a never-ending slog.
From Goals to Action

• Make sure your short-term actions support your long-term goals – all projects are energy projects.
• Emphasize the concept of total cost of ownership (TOC) approach not first costs.
• Make maximum use of available financing, grants, and services (Illinois Clean Energy Community Foundation, Public Sector Energy Efficiency Portfolio Standards, and SEDAC).
• Conduct energy assessments and get large buildings retro-commissioned.
• Plan for rising energy costs and energy volatility.
The Great Transition
From Fossil Fuels to Renewables
The Great Transition

- >80% of the world's primary energy supply is currently derived from fossil fuels.
- Concerns: energy security, climate change, 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 is renewable energy?

- 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)
Renewable Energy Available Today

Source: IEA, Johansson et al.
US Renewable Energy 2009

Total = 94.820 Quadrillion Btu

Petroleum 37%

Nuclear Electric Power 9%

Renewable 8%

Natural Gas 25%

Coal 21%

Solar 1%

Hydroelectric 35%

Geothermal 5%

Biomass 50%

Wind 9%

Total = 7.745 Quadrillion Btu

Source: USDOE/EIA Nov 2010
US Renewable Energy 2009

US Energy Consumption Growth Rates 2008-2009:
Solar/PV grew 12.4%
Wind grew 27.7%, cap grew 40% -- 10 GW
Biofuels grew 12.7%
Coal fell 10.7%
Natural Gas fell 1.7%
Petroleum fell 5.5%
Electricity fell 4.2%

Source: USDOE/EIA Nov 2010
Renewable Challenges

Transition is unavoidable, but challenging:
  - Scale of the shift.
    - lot of inertia in system – existing infrastructure, methods, habits, transition need to be larger and faster than other energy transitions i.e. dung->wood->coal->oil->ng
  - Energy density (Btu/lb)
    - Need to move more mass - w/ biomass 8 kBtu/lb than w/ NG 22kBtu/lb
  - Power density (Watts/ft²)
    - Need lots of land (or rooftops, tall poles)
  - Intermittency.
    - Sun doesn’t shine, wind doesn’t blow 24/7
  - Geographical Distribution. (IL good for wind, south for solar)
Renewables Summary

- Abundant
- Available Domestically
- Environmentally Friendly
- Technologies are maturing
- Economics often competitive with electric grid, improving all the time
- Many Incentives Available
- Our future – best production option
Putting it Together

• All Systems aligning, driving us to a more efficient, managed and renewable energy future.
  ▫ Affordability (ability to pay)
  ▫ Availability (ability to acquire)
  ▫ Sustainability (keeping options open)
  ▫ Security (limiting vulnerabilities)

• Efficiency – run away favorite energy source

• Energy Management – necessary focus and follow through

• Renewables – Nature’s energy gift
Putting it Together

• Significant incentives in place now, will expand in the future.
• Energy Issues are not going to go away. The current dip in energy prices is temporary. Social and environmental externalities are growing.
• New codes and legislation will require better designs and, eventually, retrofits.
• The challenge is enormous – but it can and must be met. Stay tuned for ideas…. 
Illinois Smart Energy
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