The Challenge of Energy Efficiency and Sustainability

Donald Fournier
Managing Director SEDAC
University of Illinois at Urbana/Champaign
The Challenges Ahead

• The Over-arching Drivers
  ▫ Fossil Fuels
  ▫ Nuclear Power
  ▫ Climate Issues

• Meeting the Challenge

• The Great Transition
Fossil Fuels
Unfortunately, business as usual isn’t possible.
Current U.S. energy supply is 83% fossil fuels; demand is broadly distributed among the major sectors.

2009 total U.S. energy use = 94.6 quadrillion Btu

Energy supply:
- Petroleum: 37%
- Natural Gas: 25%
- Coal: 21%
- Renewable: 8%
- Nuclear: 9%

Energy demand:
- Industrial (non-electric): 20%
- Transportation: 29%
- Residential & Commercial (non-electric): 11%
- Electricity - Residential: 15%
- Electricity - Commercial: 15%
- Electricity - Industrial: 10%
- Industrial: 30%

Source: EIA Annual Energy Review 2009
Crude Oil Spot Price (WTI)

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 – 73.6 Mb/day

Source: USDOE 2011

Source: DOE/EIA  Feb 2011
International Energy Agency 2010 Assessment of Oil

- Unconventional oil
- Natural gas liquids
- Crude oil: fields yet to be found
- Crude oil: fields yet to be developed
- Crude oil: currently producing fields

Note: The diagram indicates a significant increase in unconventional oil production from 2010 to 2035, with a label for Saudi Arabia.
Where to with Oil?

- Deeper and Deeper.
  - Deep and Ultra-deep
  - We’re at the technological limits for now.
  - Total recoverable resources are ~89 GB.
- Off to the wild places.
  - Polar ~52 GB.
  - Heavy (incl. tar sands & shale) ~226 GB.

BP’s Macondo Well
Source: http://cgvi.uscg.mil/media/main.php?g2_itemId=836285
Horizontal Wells to Fracture Shale

Conventional non-associated gas

Coalbed methane

Conventional associated gas

Seal

Sandstone

Tight sand gas

Gas-rich shale

Land surface

Oil
Roughly 90 percent of the 450,000 gas wells in the U.S. use hydraulic fracturing.

The new gas play is not without risks.

About 4 million of gallons of water and thousands of pounds of chemicals are pumped into the well under intense pressure to fracture the rock and release the gas.

NY State has a moratorium on fracking.

USEPA re-examining the health risks with study due out in 2012.

Photo © Heather Rousseau / Circle of Blue
The Fossil Bottom Line

- The step change 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.
- Price volatility is a real and present danger. It will worsen as world economy recovers.
- Electrical restructuring will result in electrical price increases (and you haven’t see anything yet.)
A Nuclear Renaissance?

- Nuclear power provides 20% of our electricity.
- That has stayed constant due to up-rating of existing plants and bringing one shutdown plant back on line (Browns Ferry 1).
- One plant is under construction (Watts Bar 2).
- Seventeen applications for combined construction and operating licenses for 26 reactors have been submitted to the NRC.
- Around the world 50 reactors are being built today and another 130 or more planned to come online during the next 10 years.

“The sober warning is that if more is not done, nuclear power will diminish as a practical and timely option for deployment at a scale that would constitute a material contribution to climate change risk mitigation.” The Future of Nuclear Power, MIT, 2009
Levelized Cost of Electricity

Notes:
Assumes Federal & state incentives.
CSP assumes trough technology.
Natural gas price of $4.57/MMBTU

Source: Navigant Consulting, Inc., July 2010
The Nuclear Bottom Line

• So, how many are we going to build?
• It looks like about six:
  ▫ EPAct 2005 provide for assistance to the first 6 GW of new plants.
  ▫ Loan guarantees, insurance against delays not caused by the utility, and production tax credits ($18 Billion pot).
  ▫ DOE has yet to regulate implementing loan guarantees.
• Industry also pushing for nukes to be part on RPS programs.
The Climate Connection
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

- There is already enough CO2 in the atmosphere to continue the warming trend for about a 1000 years.
- Humankind has been altering climate for about 9,000 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 way there with a positive return on investment in energy efficiency.
- Denial is nice, but it doesn’t change the facts or the science. That is why it is an inconvenient truth.
The Midwest GHG Reduction Accord

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Percent</th>
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<tbody>
<tr>
<td>Local Government</td>
<td>3.8%</td>
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<tr>
<td>K-12 Schools</td>
<td>2.0%</td>
</tr>
<tr>
<td>Community Colleges</td>
<td>0.1%</td>
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<tr>
<td>Public Universities</td>
<td>0.7%</td>
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<tr>
<td>State Buildings</td>
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<tr>
<td>Street Lighting</td>
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<tr>
<td>Resid.</td>
<td>26%</td>
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<tr>
<td>Comm/Ind'l</td>
<td>61%</td>
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<tr>
<td>Public</td>
<td>7%</td>
</tr>
<tr>
<td>Low Income</td>
<td>6%</td>
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Untapped Energy Efficiency Opportunities

- New Construction: 5%
- Equipment Replacement: 12%
- Retrofits: 83%
Why Increase Energy Efficiency

- Reduce operating costs of buildings.
- 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

• The public sector must adjust to the fact that energy efficiency is an issue that is here to stay.
• Addressing energy 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.
Developing a Vision of Efficiency

• Define what energy efficient operations means to you.
• Your efficiency 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.
From Vision to Goals

- Breaking the vision down to goals helps clarify what you need to measure.
- 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.
- Emphasize the concept of total cost of ownership (TOC) approach not first costs.
- Make maximum use of available financing, grants, and services (ICECF, Public Sector EEPS, and SEDAC).
- Conduct energy assessments and get large buildings retro-commissioned.
- Plan for rising energy costs and energy volatility.
The Great Transition
The Great Transition

• Over 80 percent 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.

Photon Enhanced Thermionic Emission solar conversion process. Cheap, 30% efficient, and combines two methods of conversion.
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

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
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/ft$^2$).
  - Intermittency.
  - Geographical Distribution.

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<tbody>
<tr>
<td>Power Density</td>
<td>Fossil: 10 to 100 W/ft$^2$</td>
<td>Biomass: &lt;0.1 W/ft$^2$</td>
<td>PV: 2 W/ft$^2$</td>
<td>Hydro: &lt;1 W/ft$^2$</td>
<td>Wind: 22 W/ft$^2$</td>
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We have entered interesting times.

Enhancing energy efficiency and sustainability in new and existing buildings is an imperative.

Significant incentives are in place now and will expand in the future.

This is not going to go away. Energy prices are volatile and we must deal with carbon.

New codes and legislation will require better designs and, eventually, retrofits.

The challenge is enormous – but it can and must be met.