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Changing the Global Energy Conversation

The Future of Energy
Blanton Auditorium
Wednesday March 30
11AM - Noon
Food and drinks provided
Our Mission Today

- Energy, Economy and Environment
- Energy Supply and Demand
  - 20th Century Foundational Energy
  - 21st Century Alternatives
  - 21st Century Foundational Energy
- Efficiency and Security
Energy and GDP

1980-2004

Source: UN and DOE EIA
Russia data 1992-2004 only

After: Koonin, 2008
OECD Energy Demand

Quadrillion BTUs

1980 2005 2030

OECD
United States
Europe
Other

Non-OECD Energy Demand

Quadrillion BTUs

1980 2005 2030

China
India
Latin America
Middle East
Africa
Other

U.S. Economy and Oil Price

GDP Growth (% change on 2000 chained dollars)

Year

Oil Price
- $ of the day
- $ 2010

Oil Domestic Wellhead Price ($)

http://www.bp.com/sectiongenericarticle800.do?categoryId=9037172&contentId=7068612
1970-1983 Arabian Light
1984-2010 Brent dated

Data: EIA and BP Statistical Analysis; US Department of Commerce
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U. S. Energy Flows

Source: Lawrence Livermore National Laboratory and U.S. DOE based on Annual Energy Review, 2008 (EIA, 2009)
From National Academies Press, America’s Energy Future, 2009
U. S. Energy Flows

Source: Lawrence Livermore National Laboratory and U.S. DOE based on Annual Energy Review, 2008 (EIA, 2009)
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Coal

Powder River Basin, WY
Coal

Parish Plant, TX
“Stacked Sinks”
Commerically Enabled CCS

Capture

+Oil (+/- $)

EOR

Sequestration

BEG Gulf Coast Carbon Center
Coal Challenges

- Mining Impacts
- CO$_2$
- Air Quality
- Mercury
- Fresh Water
Long-Term Oil Supply

Resources and Production

Source: IEA World Energy Outlook 2009
Long-Term Oil Supply

Resources and Production

Source: IEA World Energy Outlook 2009
Fort McMurray

Alberta

Oil Sands
U.S. SHALE LIQUIDS PROJECTIONS

3.8 Mbpd growth potential by 2020

From Morse et. al., 2012, Energy 2020: North America, the new Middle East?: Citi GPS: Global Perspectives & Solutions, figure 14, p. 17.
Oil Consumption

Per capita oil consumption (bbl/yr)

Year


BP Statistical Review of World Energy, CIA World Factbook, Census Bureaus, Marc Faber Limited, RJ Estimates
From Raymond James and Associates, Inc., August 2, 2010
Global Demand

US and China Vehicle Sales

U.S. Bureau of Transportation Statistics, RJ Estimates, China Association of Automobile Manufacturers
From Raymond James and Associates, Inc., August 2, 2010
Hybrid and advanced vehicles will gain share in all regions. By 2030, they will account for ~25% of global new-car sales.
750,000 Barrels
~ 50 Olympic Swimming Pools
~ 13 minutes
global oil consumption
Oil Challenges
~ 50 Olympic Swimming Pools

- Conventional Production Plateau
- Limited Geographic Control
- Environmental Impact
- \( \text{CO}_2 \) Emissions
- Public Perception and Policy
- Pipelines (?)
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Alternatives to Petroleum
Options to Oil

I. Unconventional Oil

II. Biofuels
Biofuels

Carbohydrates to Liquid Hydrocarbons

Perennial Cellulosic
- Sorghum
- Switch Grass
- Miscanthus
- Shrub Willow
Biofuels

Carbohydrates to Liquid Hydrocarbons

Perennial Cellulosic
- Sorghum
- Switch Grass
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Biofuels Challenges
- Fresh Water Use
- Land Access
- Conversion Facilities
- Drought
- Scale
Options to Oil

I. Unconventional Oil

II. Biofuels

III. Natural Gas (CNG, LPG, LNG)
   I. Deliverability and access

IV. Electricity (Batteries)
   IV. Charging today means coal, natural gas, nuclear...
Options to Oil

I. Unconventional Oil

II. Biofuels

III. Natural Gas (CNG, LPG, LNG)
   1. Deliverability and access

IV. Electricity (Batteries)
   1. Charging today means coal, natural gas, nuclear…

V. Hydrogen (fuel cells)
   1. Just ten years away!

VI. Or…
Electricity

Electricity Alternatives

(2008 Quads)

Source: Lawrence Livermore National Laboratory and U.S. DOE based on Annual Energy Review, 2008 (EIA, 2009)
From National Academies Press, America's Energy Future, 2009
Hydro Challenges

- Fresh Water Capture
- Land Use & Topography
- Drought
Hydro Challenges

- Fresh Water Capture
- Land Use & Topography
- Drought
Geothermal

Iceland

300 MW Nameplate
Geothermal Challenges

- Thermal Conversion
- Geology
Industrial Solar

Spain

Solucar, CSP
11 MW Nameplate

Andusal, PV
60 MW Nameplate

Olmedilla de Alarcon, Parabolic Troughs
50 MW Nameplate
Solar Challenges

- Cost
- Manufacturing
- Intermittency
- Energy Storage
- Transmission
- Land Use
Wind
Global Power-Generation Capacity

The Reality of Intermittency

Intermittent wind and sun reduce output of installed capacity.

Note – no changes to existing reserves requirements were assumed for this analysis
Wind Challenges

- Transmission
- Intermittency
- Energy Storage
- Siting
- Materials
- Infrastructure
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### U.S. Energy Flows

|---|

#### Emerging Foundational Energies (2008 Quads)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Energy Use (Quads)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>11.48</td>
</tr>
<tr>
<td>Commercial</td>
<td>8.58</td>
</tr>
<tr>
<td>Industrial</td>
<td>23.94</td>
</tr>
<tr>
<td>Transportation</td>
<td>27.86</td>
</tr>
</tbody>
</table>

#### Energy Services

- Nuclear: 8.45 Quads
- Natural gas: 23.84 Quads
- Electricity generation: 39.97 Quads
- Energy services: 42.15 Quads

#### Energy Flows

- Electricity generation: 39.97 Quads
- Electricity imports: 0.11 Quads
- Residential: 11.48 Quads
- Commercial: 8.58 Quads
- Industrial: 23.94 Quads
- Transportation: 27.86 Quads
- Energy services: 42.15 Quads

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Nuclear

Le Hague Waste Recycling
Normandy, France
Nuclear Challenges

- Natural and Human Disasters
- Front End Cost
  - Permitting and Regulatory
- Waste Protection
- Proliferation
Natural Gas Supply - Resources and Production

Source: IEA World Energy Outlook 2009
LNG - Conventional Natural Gas

Qatar
North Field
U.S. Natural Gas

Production and Reserves

Marketed Production (Tcf)

Proved Reserves (Tcf)

Annual U.S. Production

End-of-Year U.S. Proved Reserves

After Steve Harvey, EIA
U.S. Natural Gas

Production

After Steve Harvey, EIA
U.S. Natural Gas

Production

EXHIBIT 8: UNITED STATES UNCONVENTIONAL GAS OUTLOOK (BCF/DAY)

Source: Modified from American Clean Skies, Summer 2008

After Steve Harvey, EIA
Long-Term Natural Gas Supply

Resources and Production

Source: IEA World Energy Outlook 2009
North American shale plays
(as of May 2011)

Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI.
Updated: May 9, 2011
Barnett Shale

Nanopores in Organics

Orange dots are 20 nm in diameter

Human Hair

50 µm

0.2 µ

200 nm

T.P. Sims #2; 7625’

After Reed, BEG
Innovation driven by necessity

Barnett drilling location
University of Texas at Arlington
From XTO annual report
U.S. Shale Gas

Implications

- Environmental
  - Traffic (-)
  - Noise/light (-)
  - Water (-)
  - Land Use (-)
  - NORM (-)
  - Carbon (+/-)
- Energy Security (+)
- Fuel Diversity (+)
Natural Gas Challenges

- Deliverability
- Access
- CO$_2$ Emissions
- Water
- Micro Quakes
- Educated Regulation
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U. S. Energy Flows

Efficiency

(2008 Quads)

Source: Lawrence Livermore National Laboratory and U.S. DOE based on Annual Energy Review, 2008 (EIA, 2009)
From National Academies Press, America’s Energy Future, 2009
Efficiency

- Fuel
- Lighting
- Electronics
- Insulation

Energy efficiency can be improved across all consumption sectors.
U.S. Independence?

- Petroleum/NGL Produced, 15
- Petroleum/NGL Imported, 19
- Natural Gas Produced, 24
- Natural Gas Imported, 2
- Coal, 22
- Nuclear (Uranium), 8
- Hydropower, 3
- Biomass, 4
- Renewables, 2
- Other, 1
- Other, 1

Source: EIA, 2012
Energy Security

Available
Access to substantial, national resources

Affordable
Electricity: produced Kwh
Facility: to build the plant
Volatile: stable fuel price

Reliable
Intermittent: stable source
Safe: harm from natural/human causes

Environmental
Dense: small land footprint
Dry: fresh water use or potential risk
Clean: air emissions ($\text{CO}_2$ is part of clean)
Framework for Energy Security

- Increased **global** Efficiency
- **Diversify** the **global** energy portfolio
- Improved **global** energy Infrastructure
- Strengthen **global** Energy Trade
- **Dialog** between Developed and Developing Nations
- **Global Policy** that engages Energy, Economy and Environment
A Look at the Global Future

Petroleum Consumption
Coal Consumption
Natural Gas Consumption
Nuclear Electric Power Consumption
Hydroelectric Power Consumption
Biomass, Geothermal, Solar & Wind Consumption
Five Things About Energy

• Energy transitions take time.
• Efficiency requires a change in thinking.
• The 20th Century was coal and oil; the 21st century will be nuclear and natural gas.
• Every form of energy has pros and cons.
• Energy demand is about people.
Hook em!

http://www.facebook.com/SwitchEnergyProject

http://www.switchenergyproject.com/