



U.S. Energy Outlook: Whatever Happened to "Peak Oil"?

Tudor Lecture | Indiana University | 6 February 2012

Dr. Marcia McNutt
Director, U.S. Geological Survey

Department of the Interior
U.S. Geological Survey



U.S. Energy Outlook: Whatever Happened to "Peak Oil"?

Tudor Lecture | Indiana University | 6 February 2012

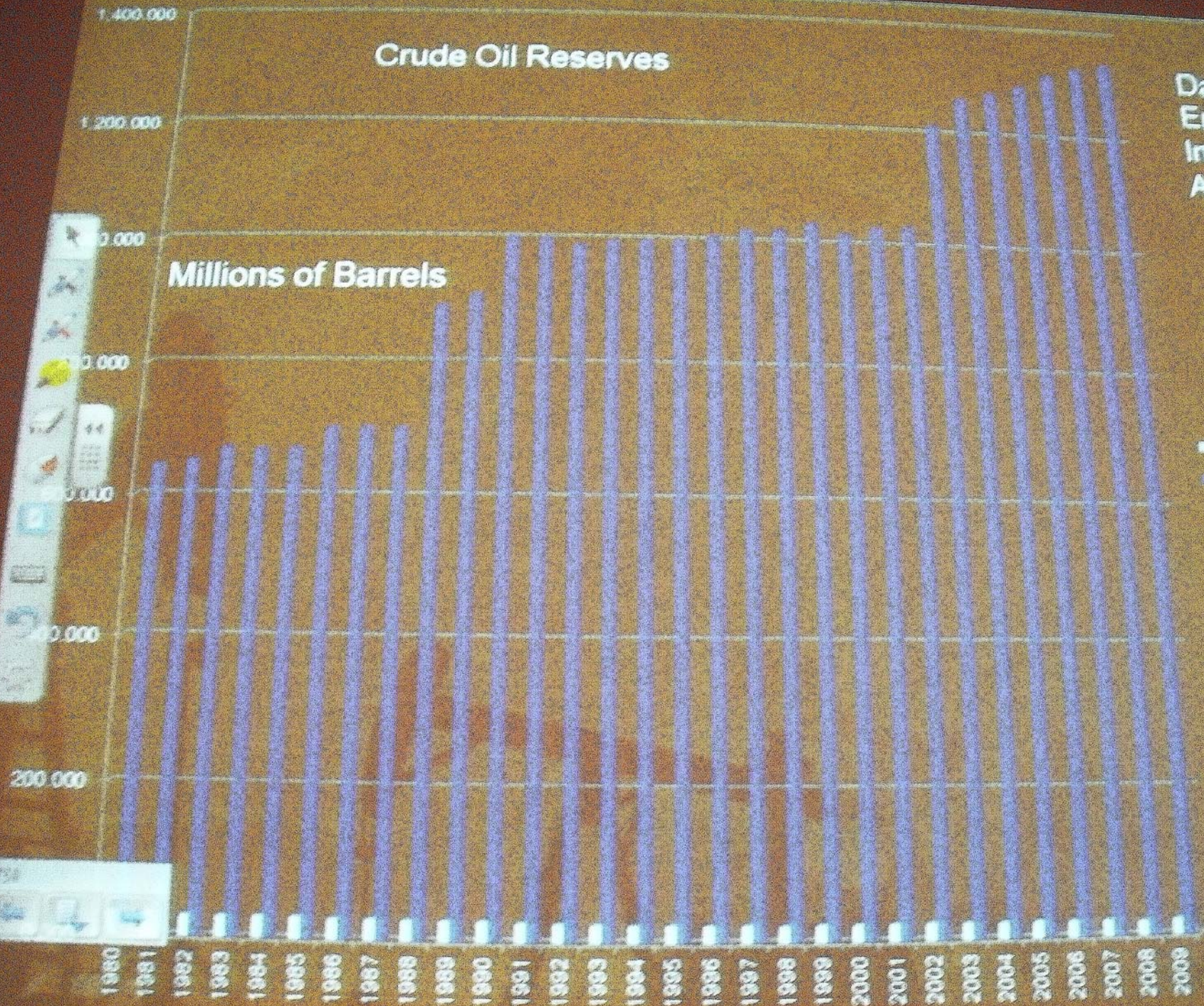
Dr. Marcia McNutt
Director, U.S. Geological Survey

Department of the Interior
U.S. Geological Survey

Crude Oil Reserves

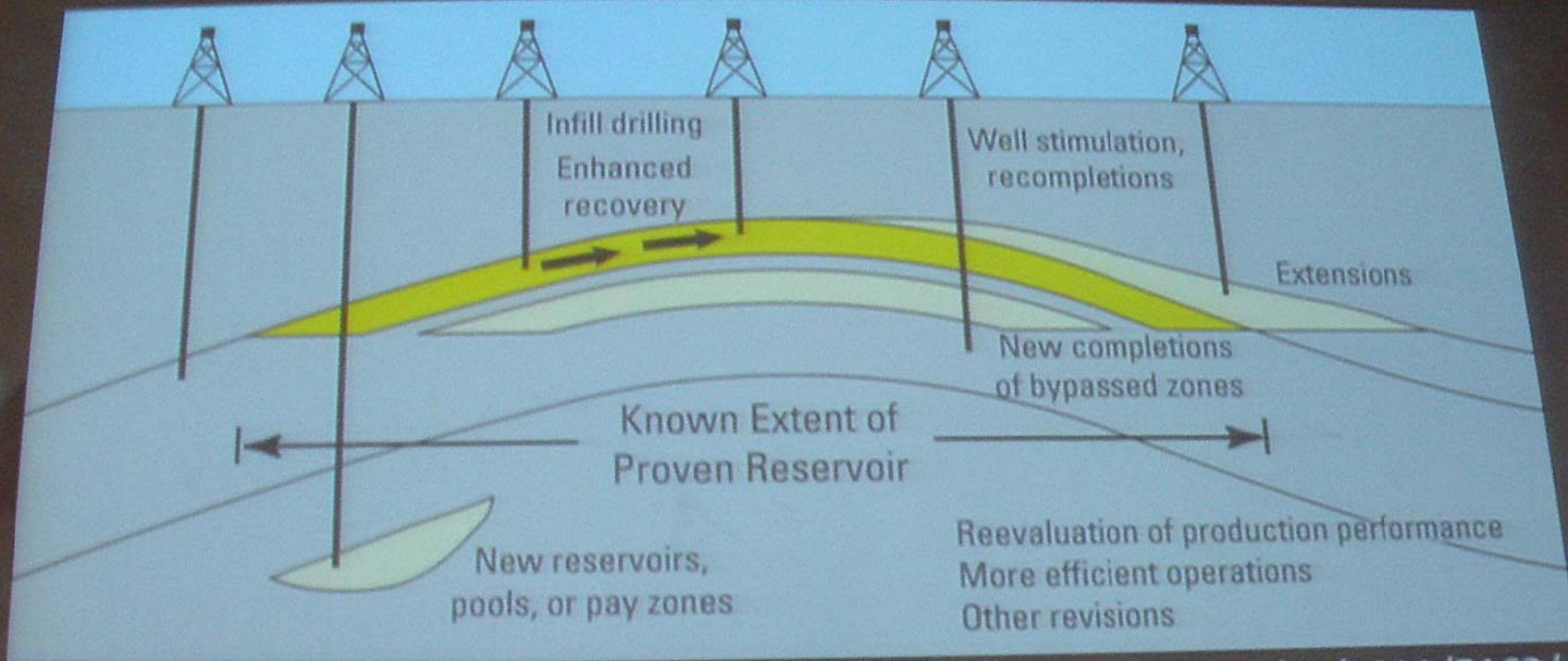
Data from
Energy
Information
Agency

Millions of Barrels



Reserve Growth

New U.S. Geological Survey Method for the Assessment of Reserve Growth

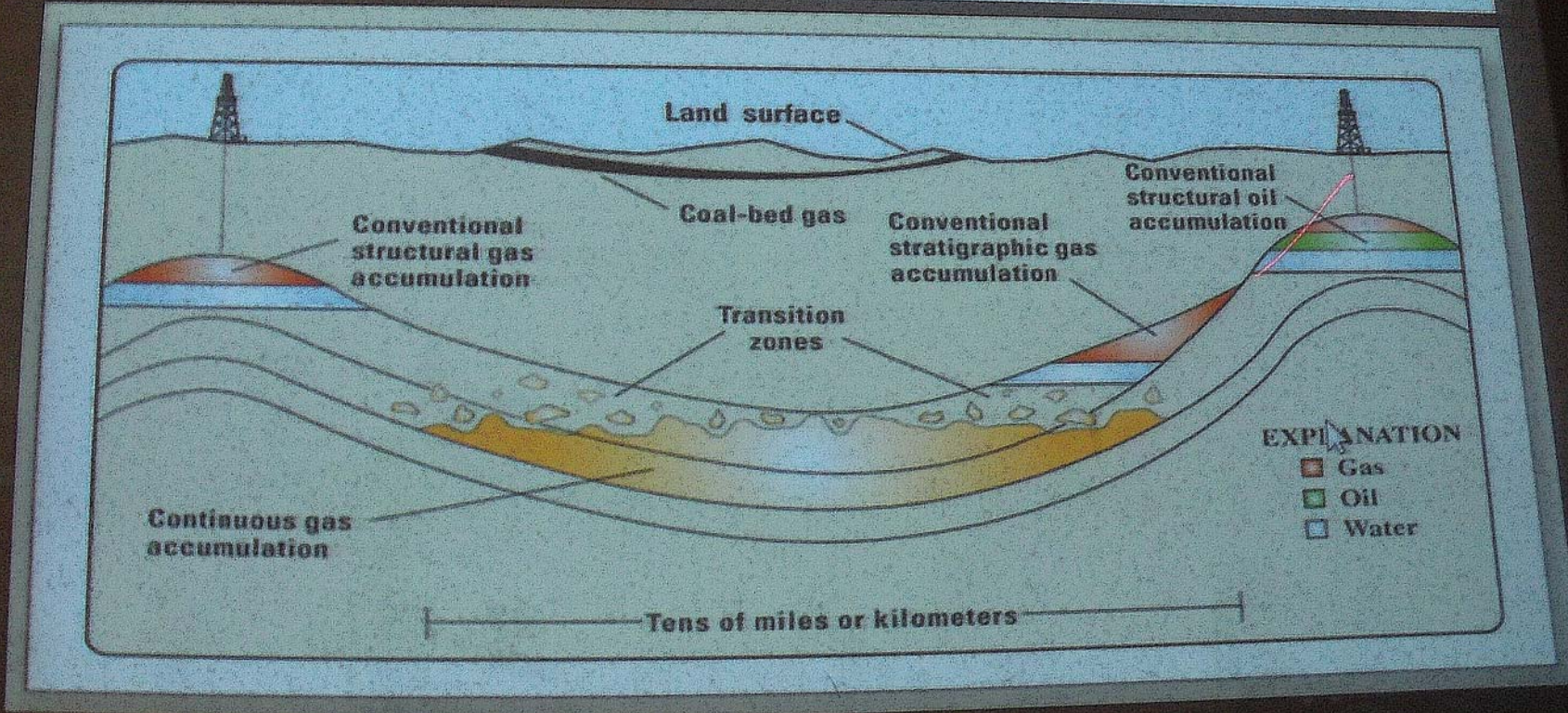
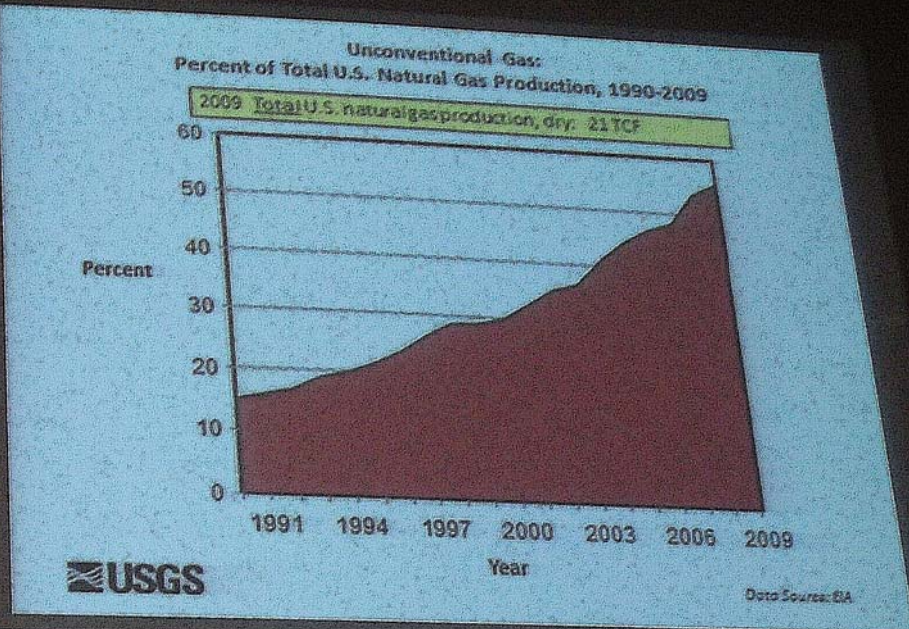


<http://pubs.usgs.gov/sir/2011/5163/>

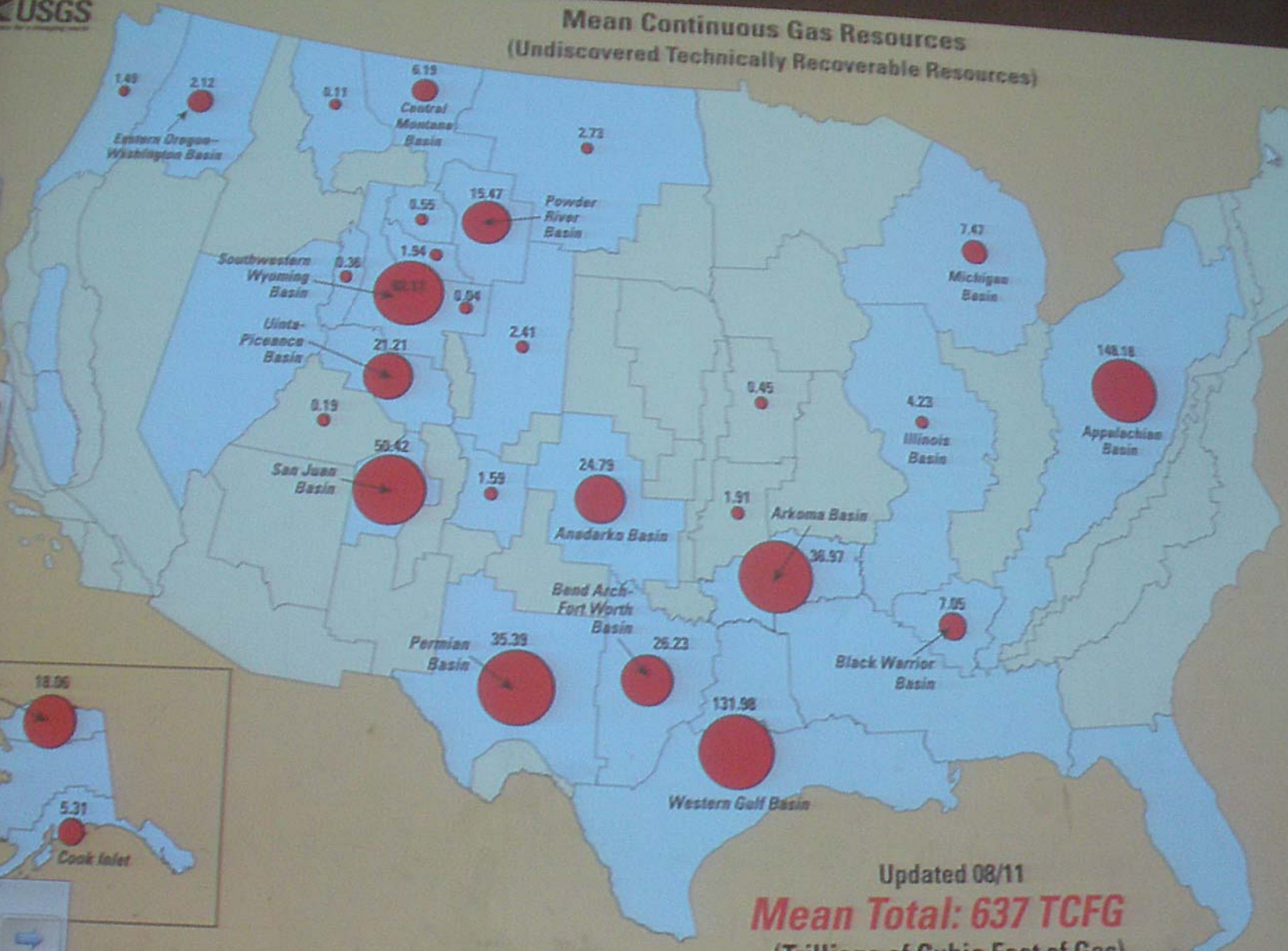
Conceptual diagram illustrating how changes in geologic understanding of petroleum resource accumulations can affect estimates of reserves, leading to the phenomenon known as reserve growth.

Unconventional Resources

an important part of the national energy potential



Mean Continuous Gas Resources (Undiscovered Technically Recoverable Resources)



Legend

Total Gas (TCFG)

- 0.01 - 5.00
- 5.01 - 10.00
- 10.01 - 30.00
- 30.01 - 100.00

Vintage by Province

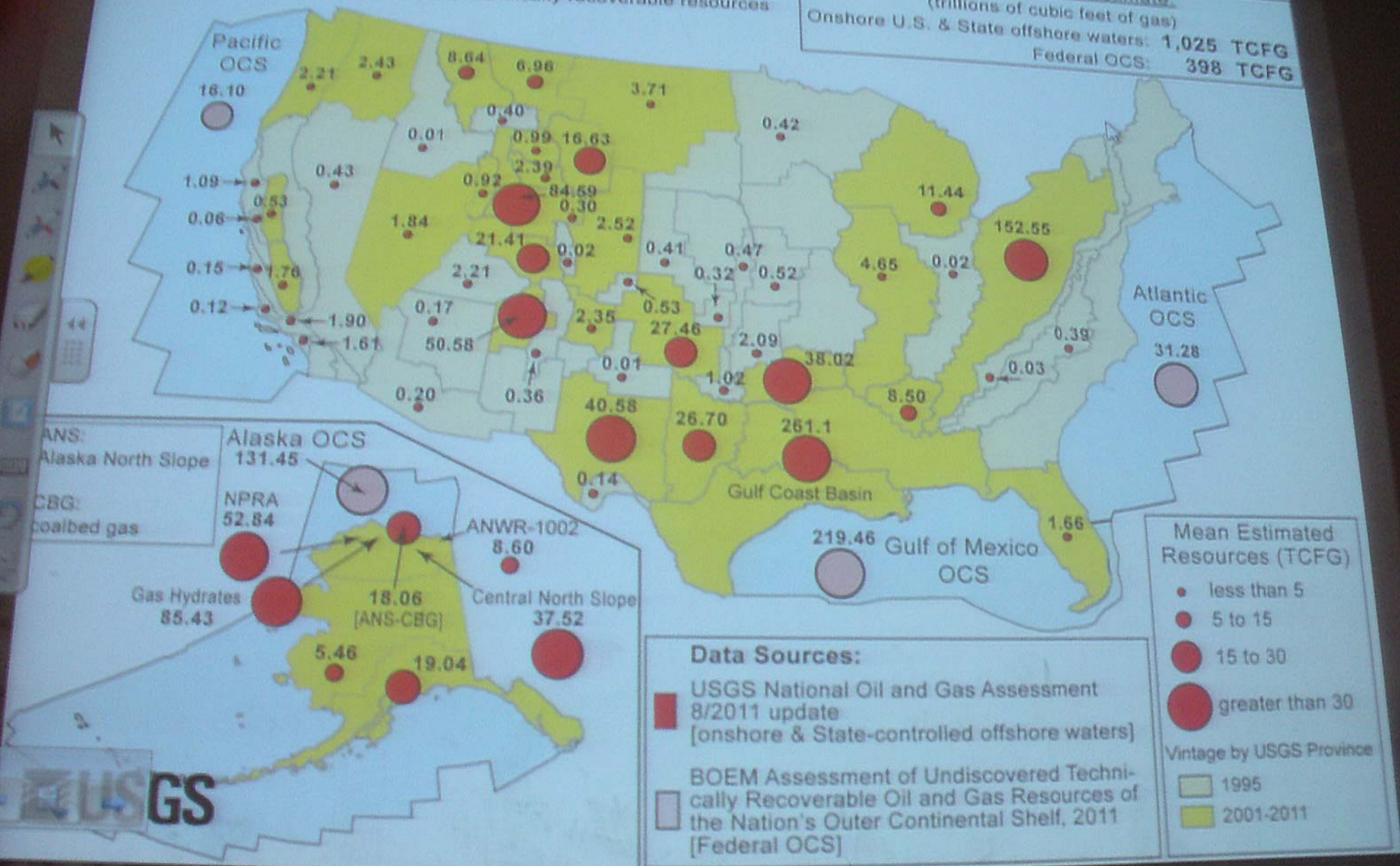
- 1980
- 2001-2011

Updated 08/11
Mean Total: 637 TCFG
(Trillions of Cubic Feet of Gas)

Natural Gas (thru 12/2011):

Mean estimate – total undiscovered, technically recoverable resources

Aggregate mean estimate:
(trillions of cubic feet of gas)
Onshore U.S. & State offshore waters: 1,025 TCFG
Federal OCS: 398 TCFG



Mean Estimated Resources (TCFG)

- less than 5
- 5 to 15
- 15 to 30
- greater than 30

Vintage by USGS Province

- 1995
- 2001-2011

Data Sources:

- USGS National Oil and Gas Assessment 8/2011 update [onshore & State-controlled offshore waters]
- BOEM Assessment of Undiscovered Technically Recoverable Oil and Gas Resources of the Nation's Outer Continental Shelf, 2011 [Federal OCS]

ANS: Alaska North Slope
 CBG: coalbed gas

Alaska OCS 131.45

NPRA 52.84

ANWR-1002 8.60

Central North Slope 37.52

Gas Hydrates 85.43

18.06 [ANS-CBG]

5.46

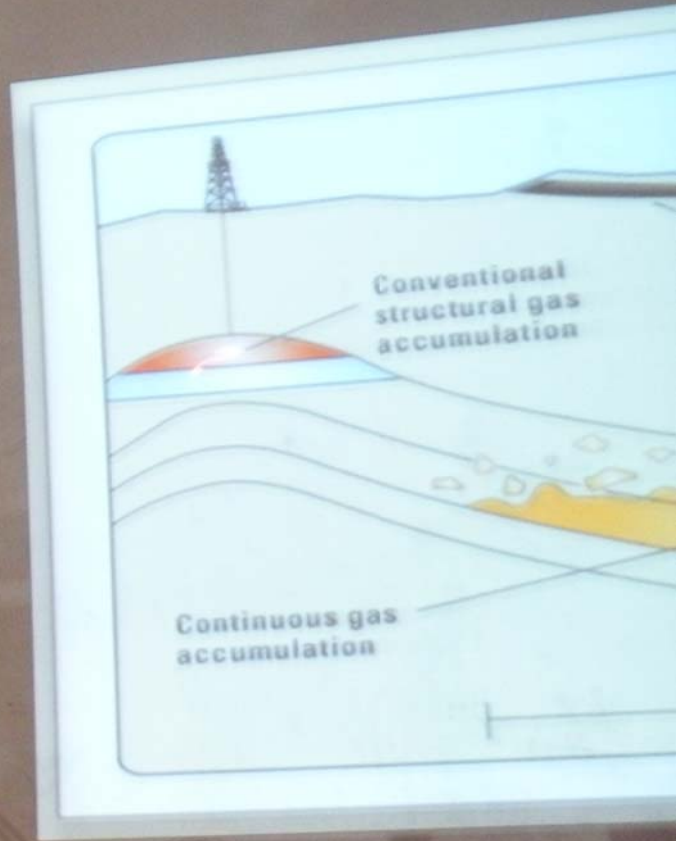
19.04



an important part of the national energy potential

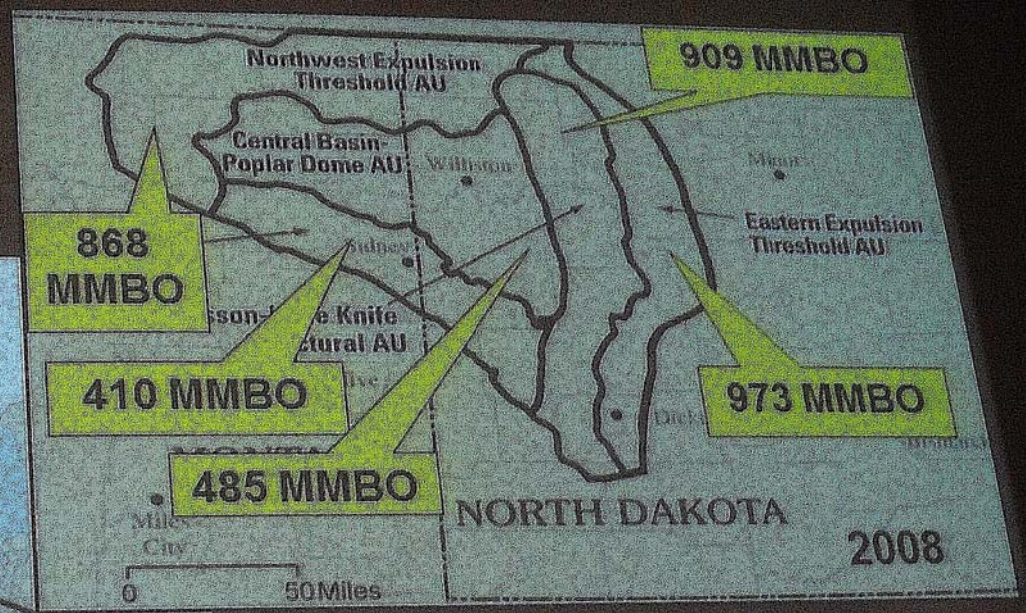
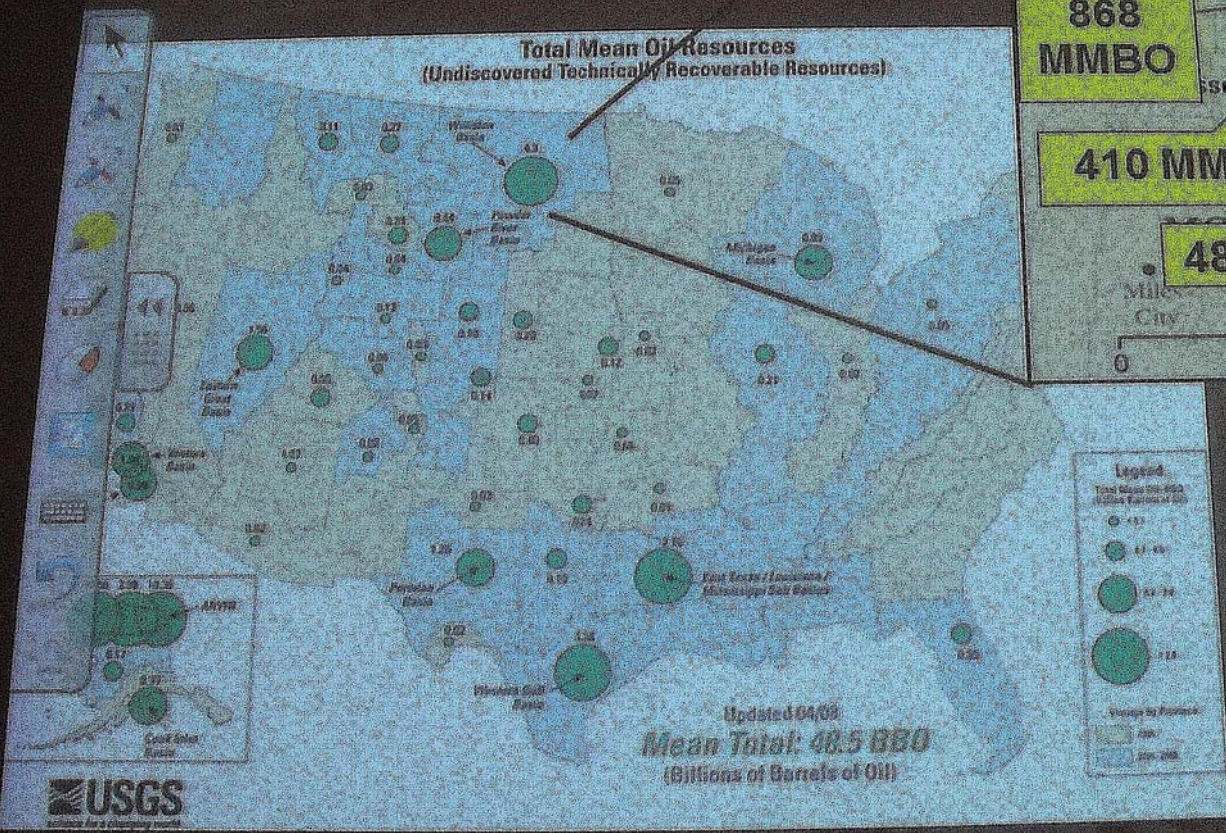


4/34



Resource Assessments Change Over Time

Bakken Formation



USGS assessments
 1995 = 151 MMBO
 2008 = 3.65 BBO (mean totals)

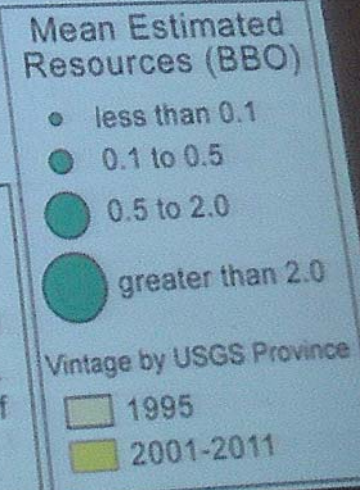
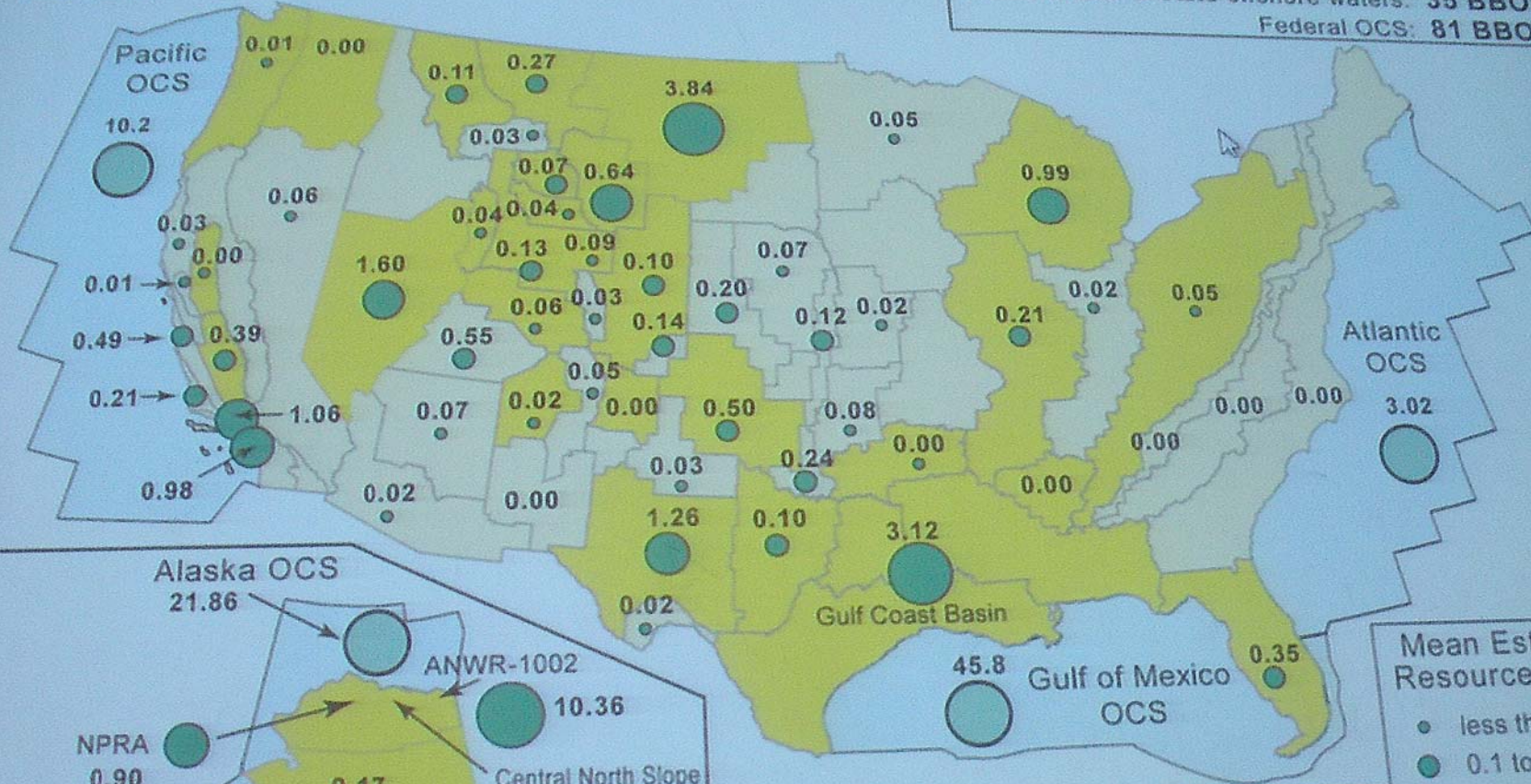
MMBO – million barrels oil
 BBO – billion barrels oil

<http://pubs.usgs.gov/fs/2008/3021/>

Oil (thru 12/2011):

Mean estimate – total undiscovered, technically recoverable resources

Aggregate mean estimate:
(billions of barrels of oil)
Onshore U.S. & State offshore waters: **35 BBO**
Federal OCS: **81 BBO**



Data Sources:
 USGS National Oil and Gas Assessment 8/2011 update [onshore & State-controlled offshore waters]
 BOEM Assessment of Undiscovered Technically Recoverable Oil and Gas Resources of the Nation's Outer Continental Shelf, 2011 [Federal OCS]



Gas Hydrates

Natural gas hydrates are solid forms of natural gas, ice-like in appearance.



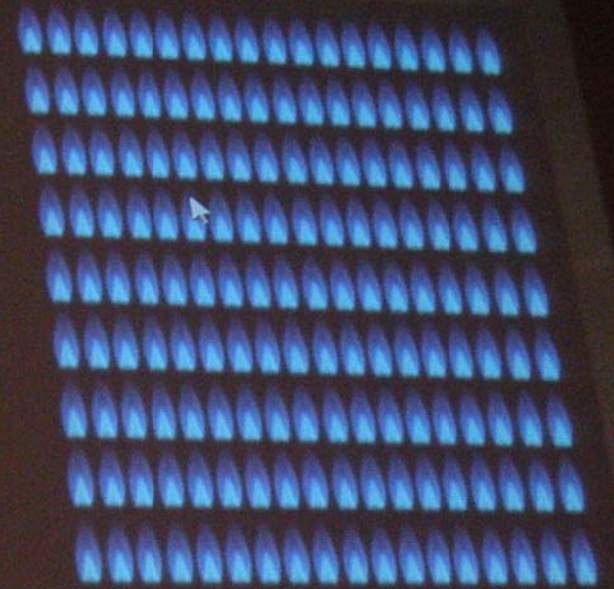
Map showing global distribution of recovered, inferred or potential gas hydrate occurrences.



Modified from Kvenvolden and Rogers (2005)



=



1
Gas in
hydrate form

=

160+
Gas at standard
temperature and pressure



Top Coal Producing States, 2010

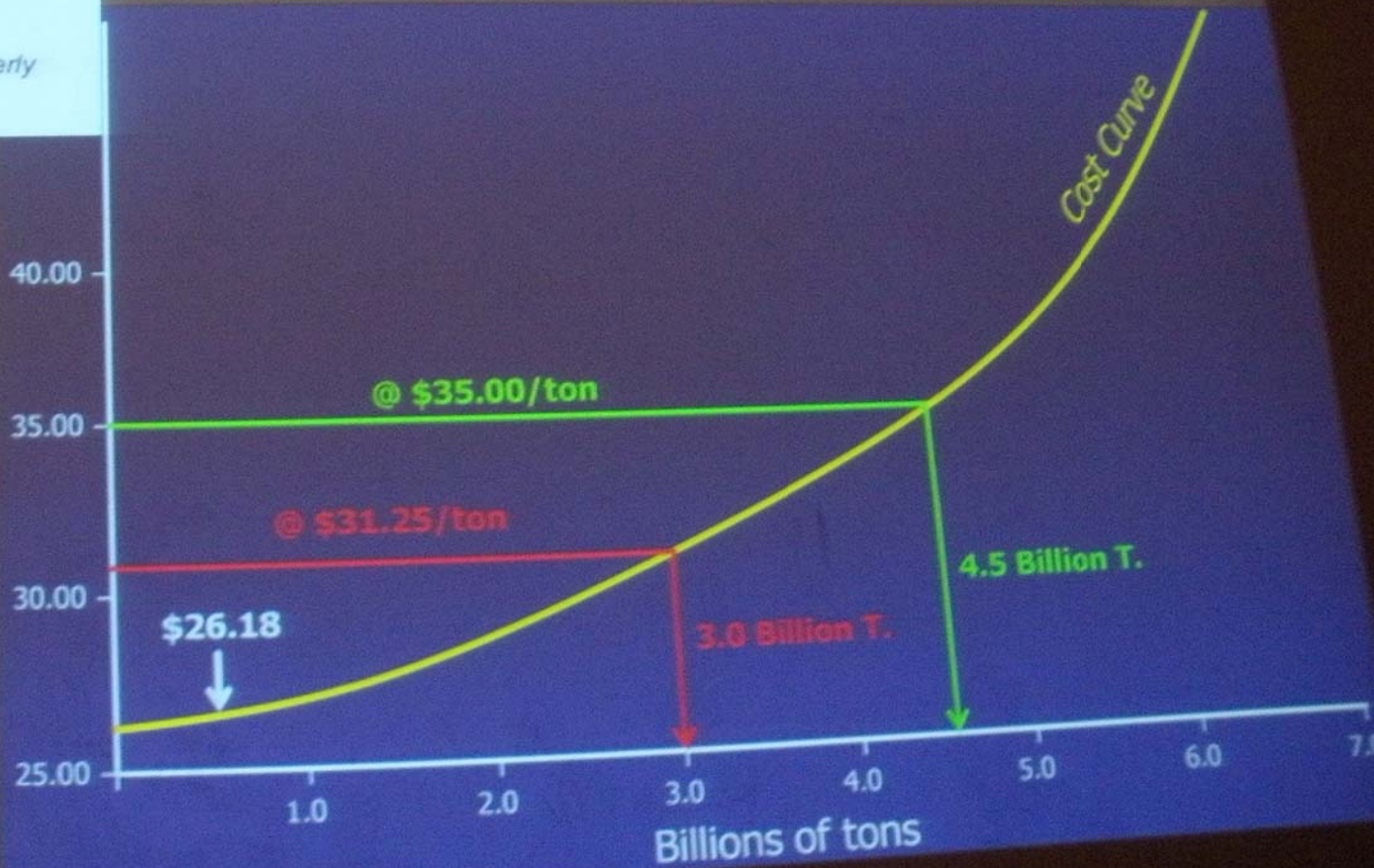


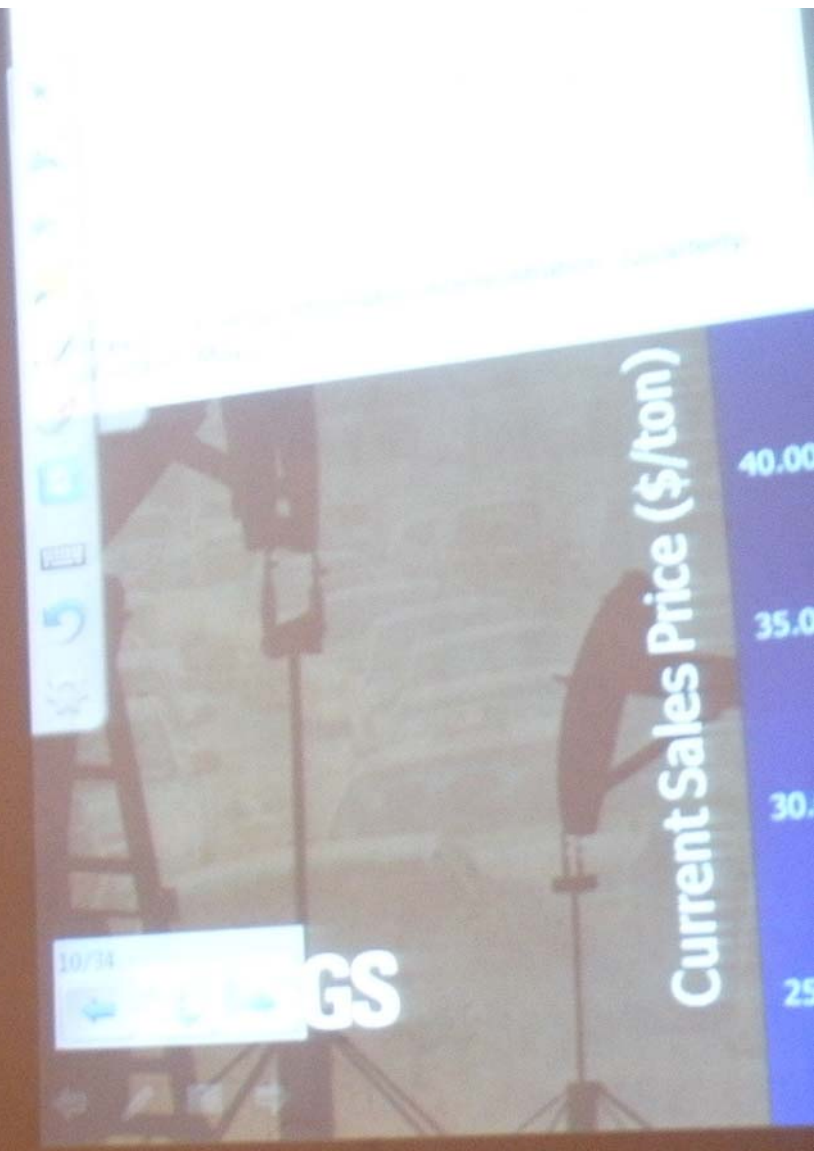
U.S. Energy Information Administration, Quarterly Coal Report (May 2011).

Coal Resources and Reserves

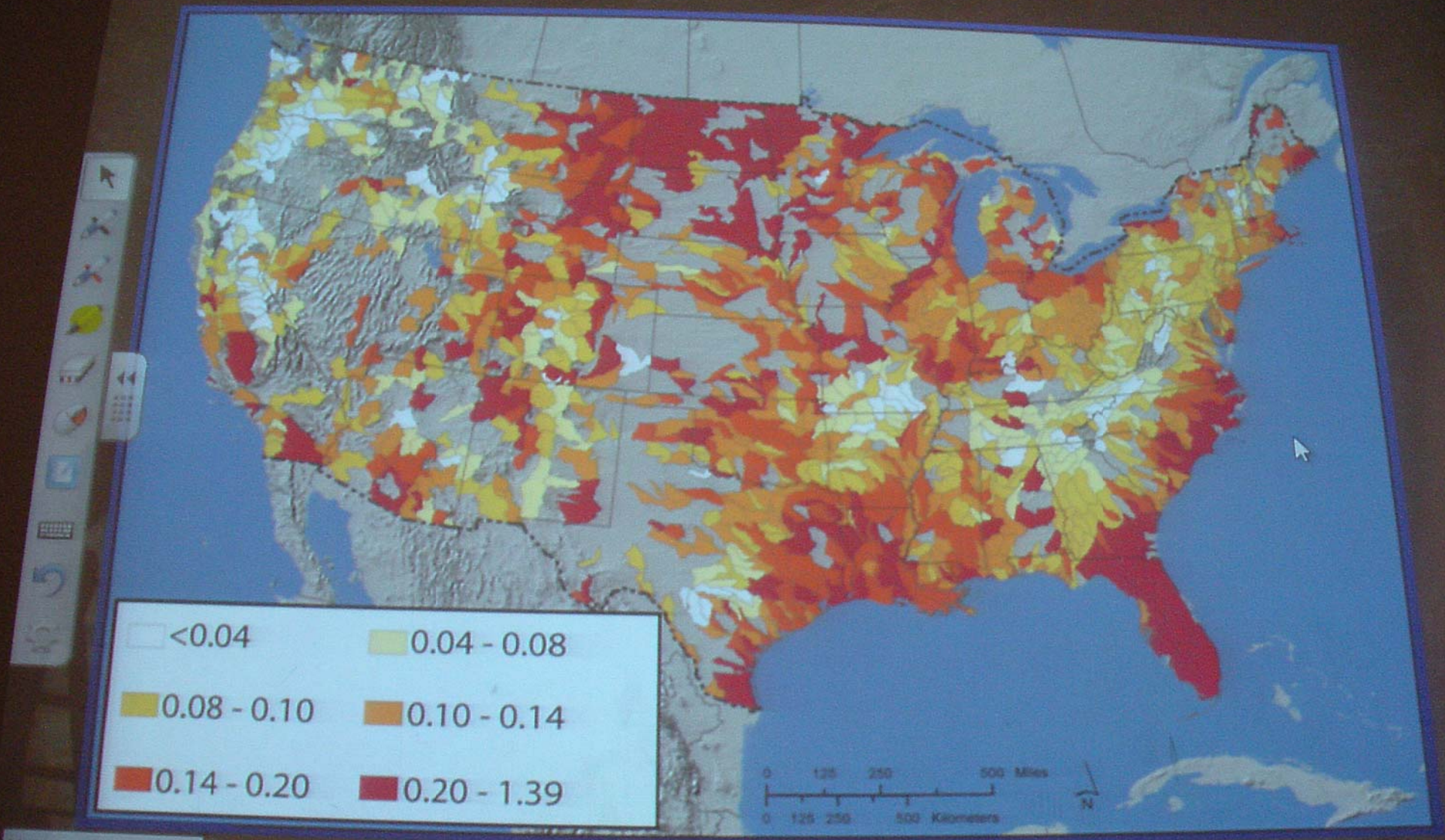
Modified from Luppens and others (2006).

Current Sales Price (\$/ton)

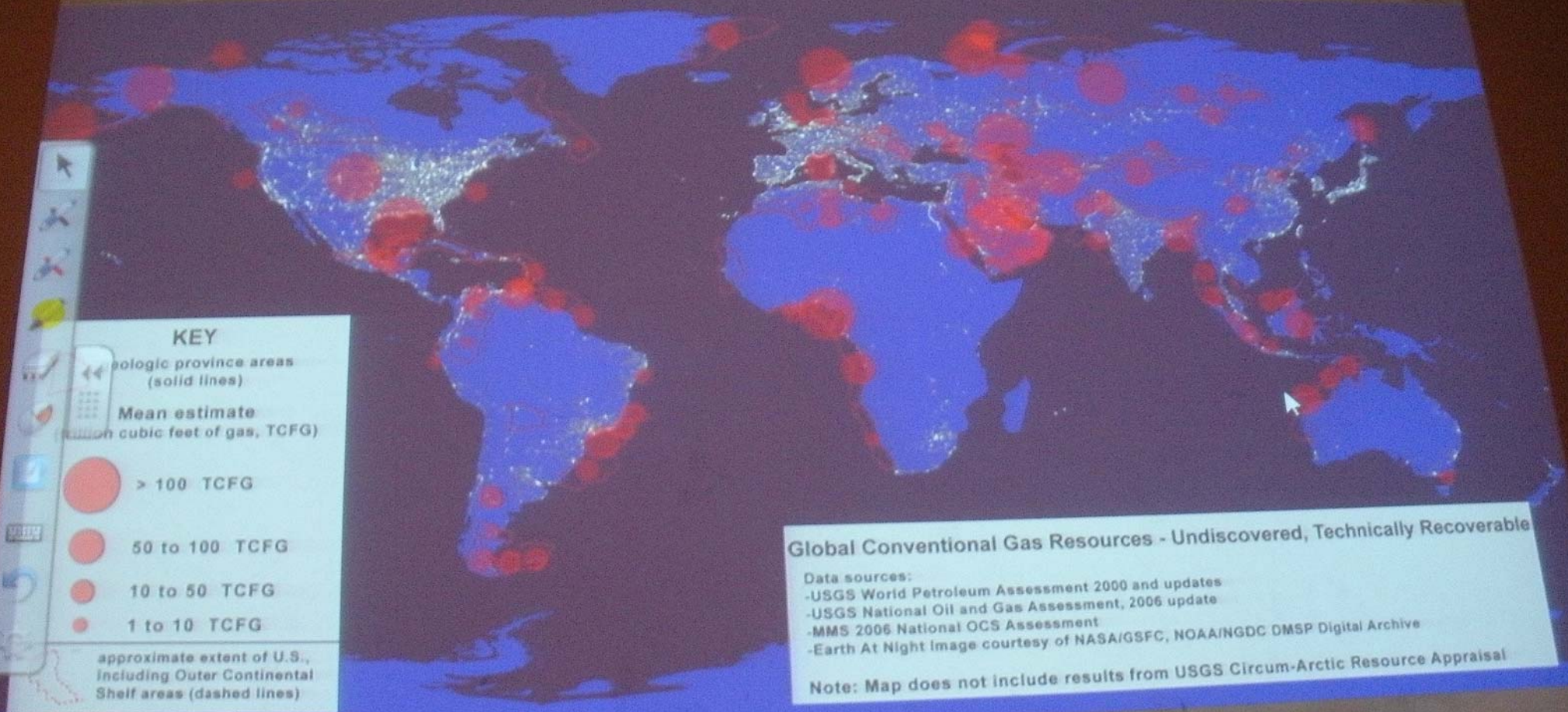




National Map of Methylmercury Concentrations

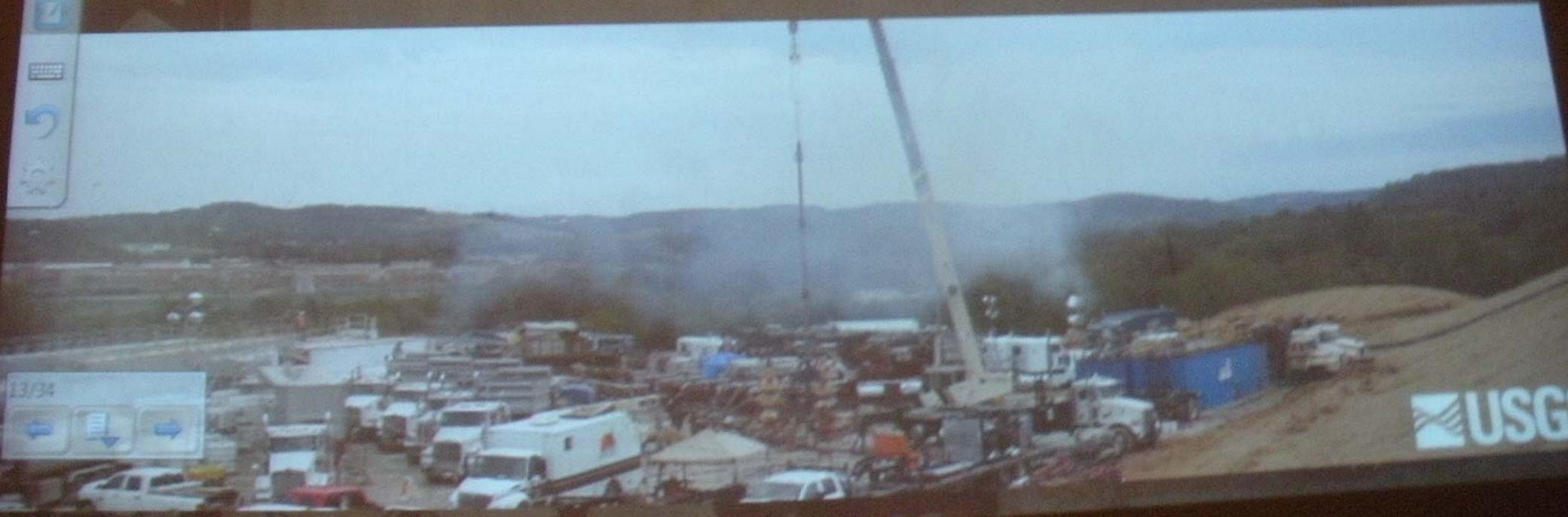


Global Conventional Gas Resources

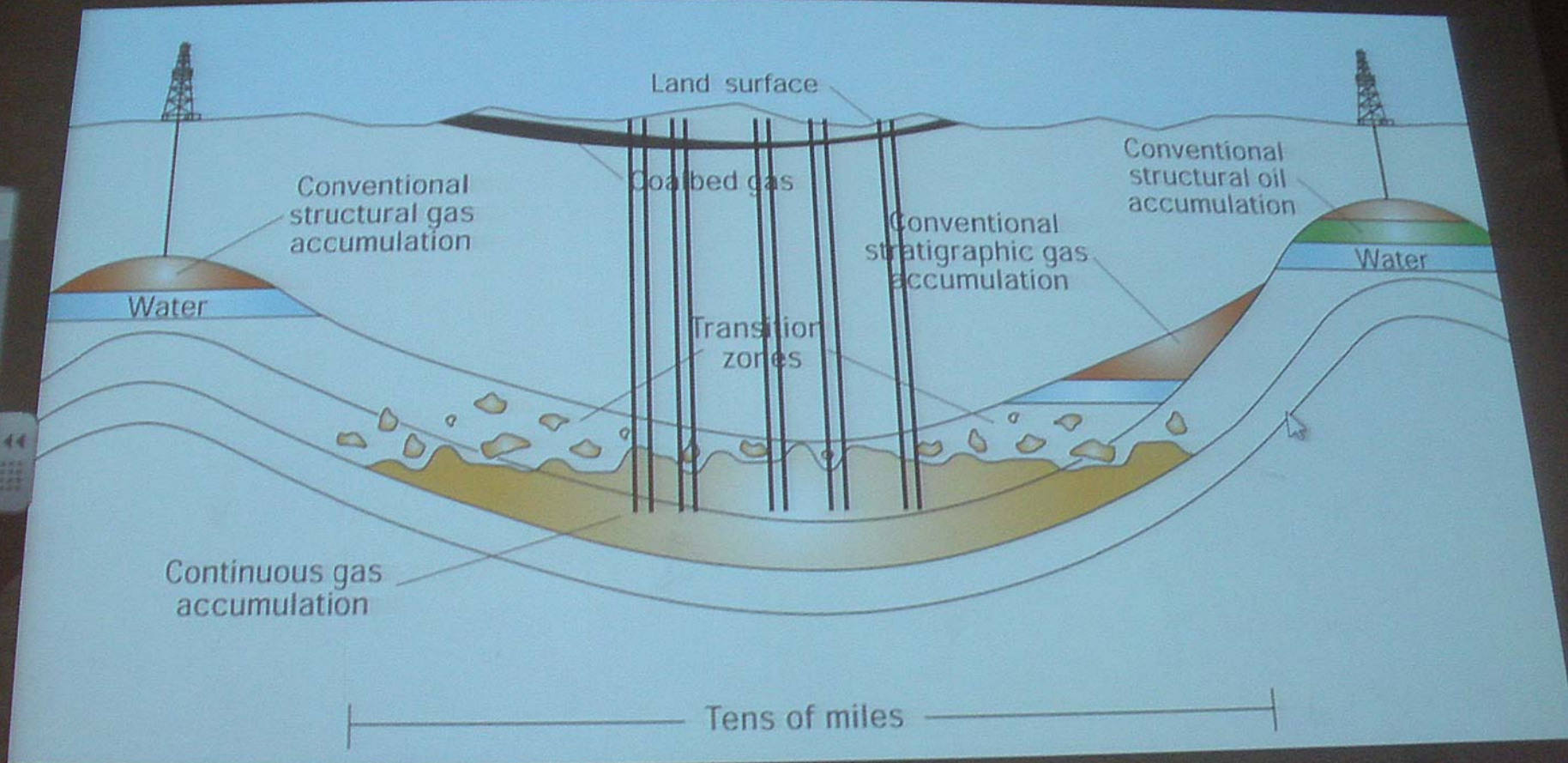


New Challenges: "The Fracking Debate"

- Consumptive water use
- Potential for aquifer contamination
- Induced seismicity
- Landscape impacts

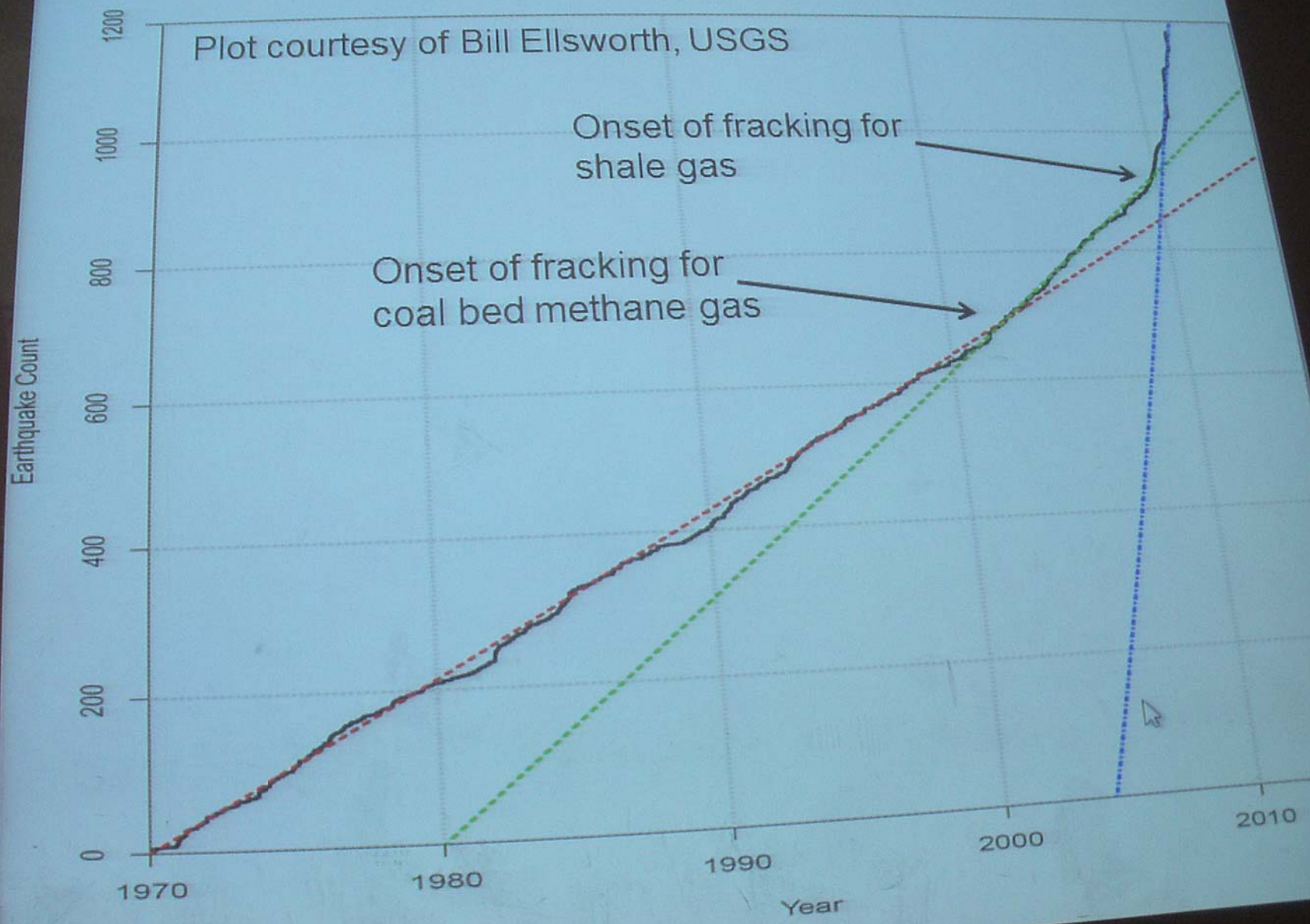


Water Impacts from Fracking

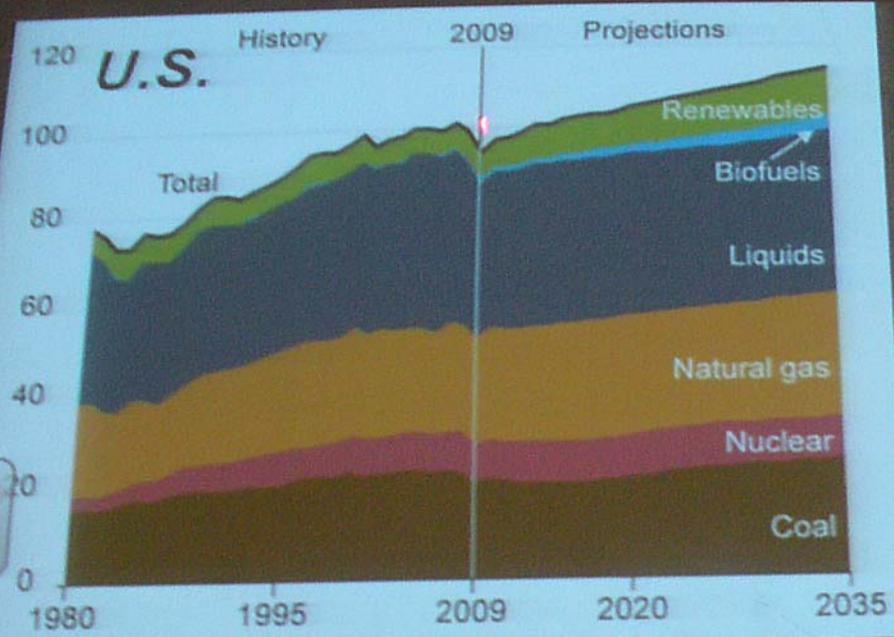


Seismic Impacts from Fracking

Cumulative Number of Earthquakes for $M \geq 3$

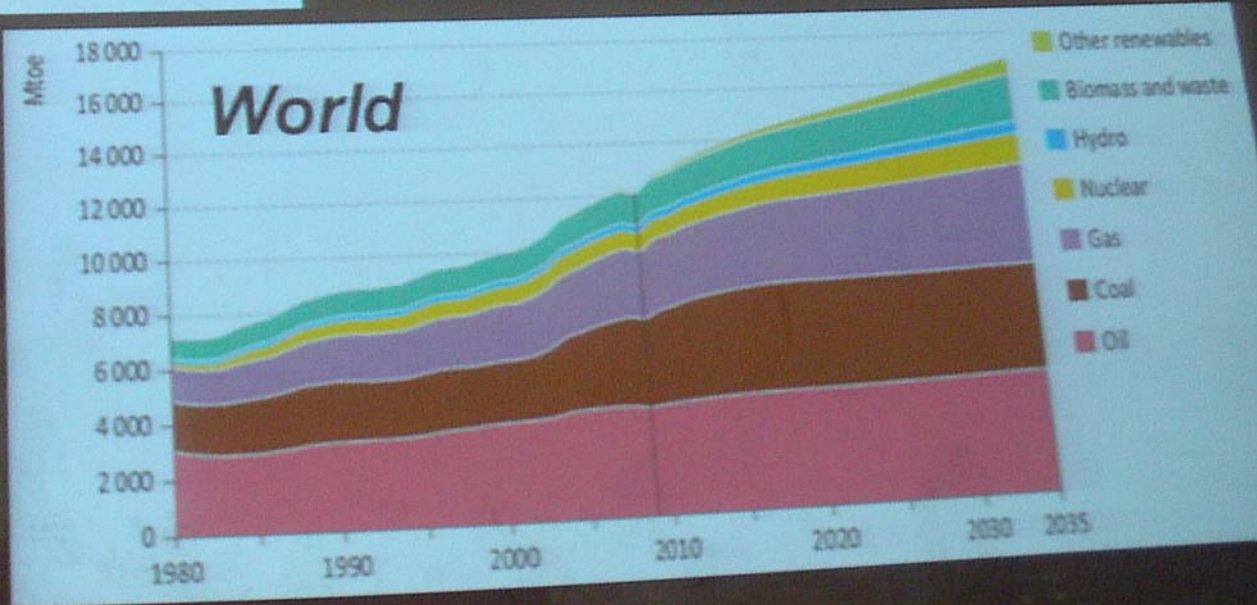


Energy consumption by fuel, past and projected



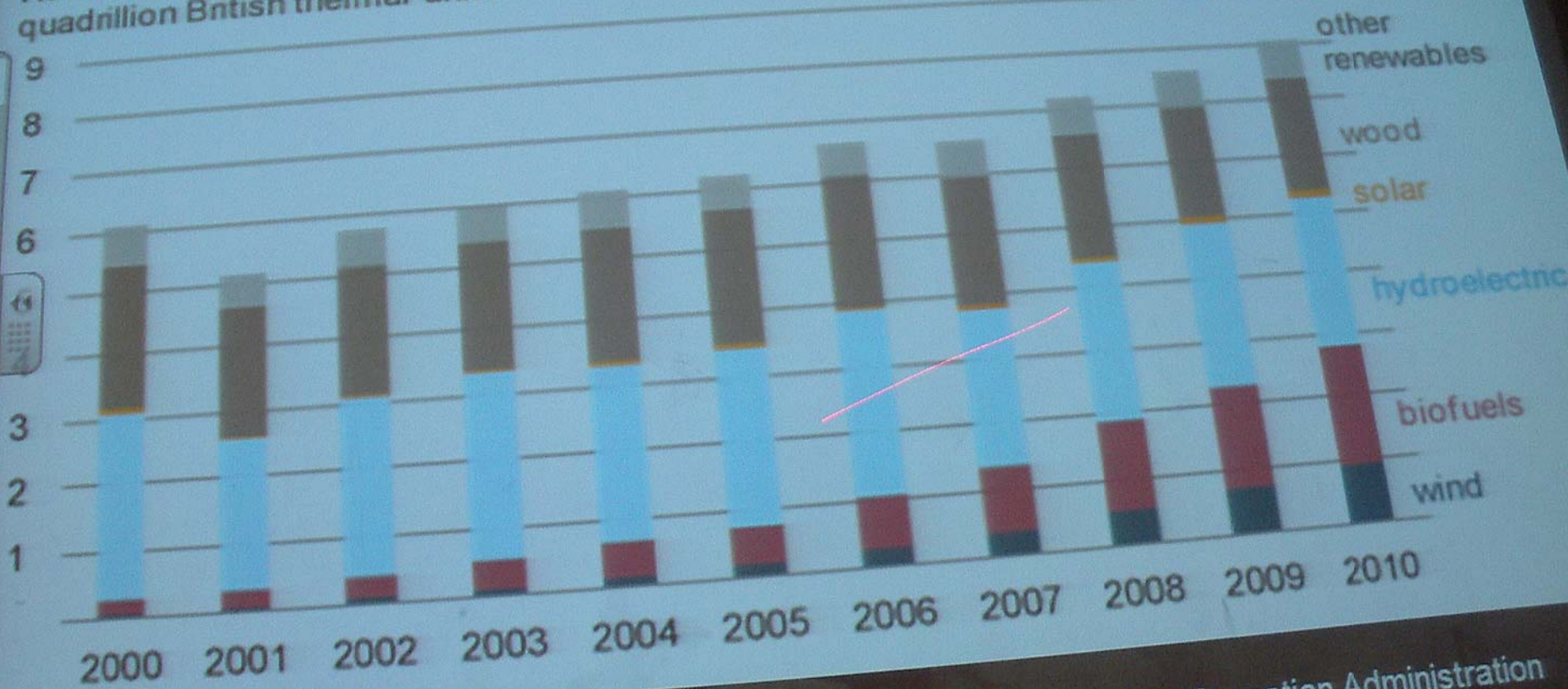
Energy Information Administration
Annual Energy Outlook 2011

International Energy Agency World Energy Outlook 2011



Renewable Energy Use – U.S.

Renewable energy consumption by primary energy source, 2000-2010
quadrillion British thermal units



Energy Information Administration

Wind Energy

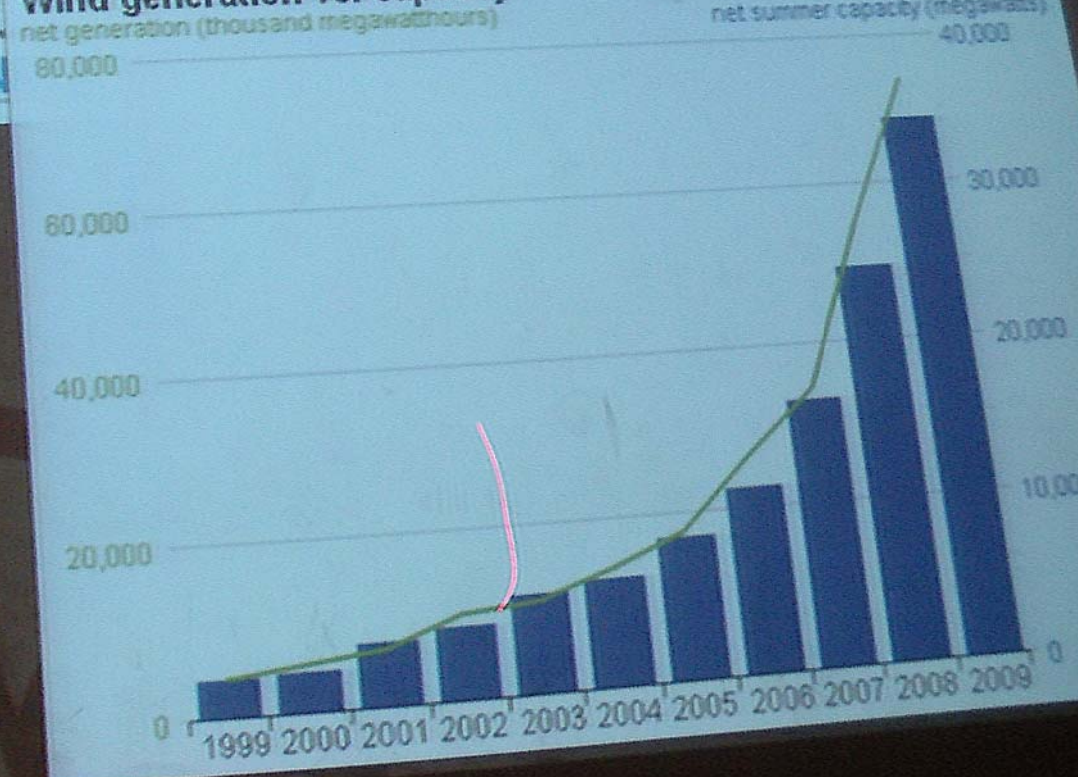
Current Installed Wind Power Capacity (MW)



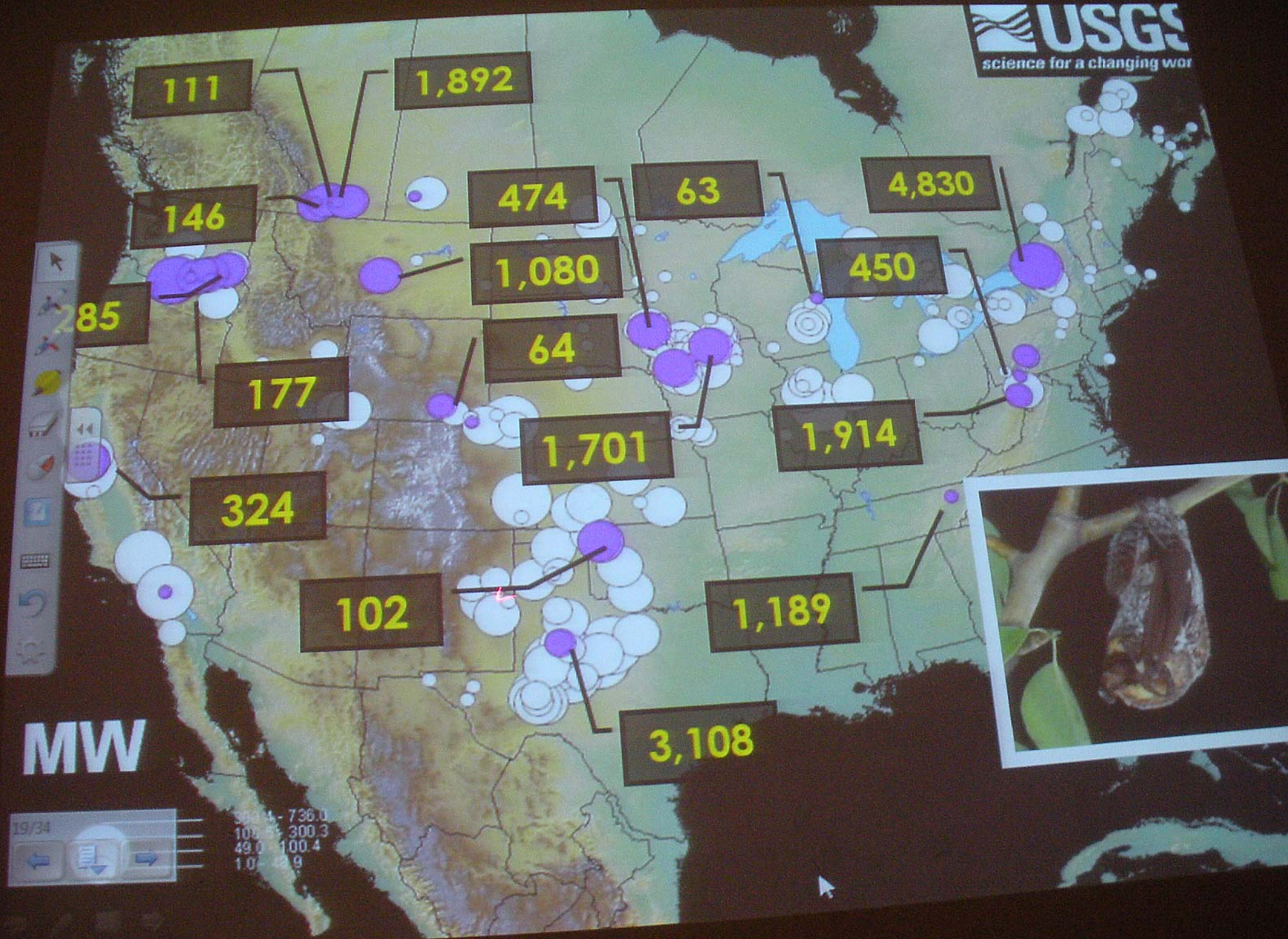
Data is from the American Wind Energy Association Second Quarter 2011 Market Report: <http://www.awea.org>

<http://www.eia.gov/cneaf/solar.renewables/page/wind/wind.html>

Wind generation vs. capacity



http://www.windpoweringamerica.gov/wind_installed_capacity.asp



MW

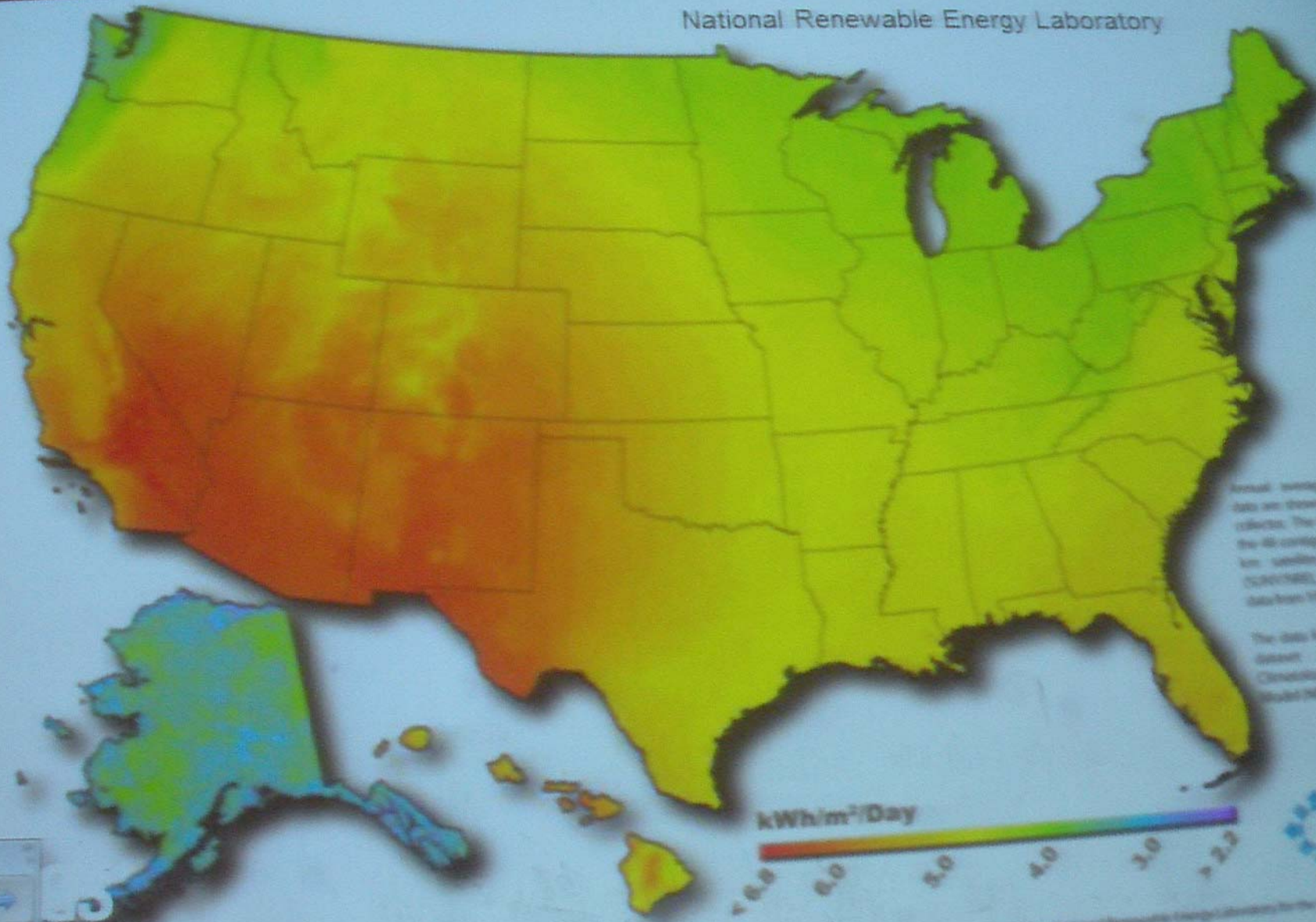
19/34

Navigation icons: back, forward, search, and other controls.

330.4 - 736.0
108.5 - 300.3
49.0 - 100.4
1.0 - 2.9

The Geography of Solar Energy Potential

National Renewable Energy Laboratory



Annual average solar resource data are shown for a 20-kilowatt collector. The data for Hawaii and the 48 contiguous states are a 10 km satellite modeled dataset (NREL/2002, 2007) representing data from 1996-2005.

The data for Alaska are a 40 km dataset produced by the Climatological Solar Radiation Model (NREL, 2002).



This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy.

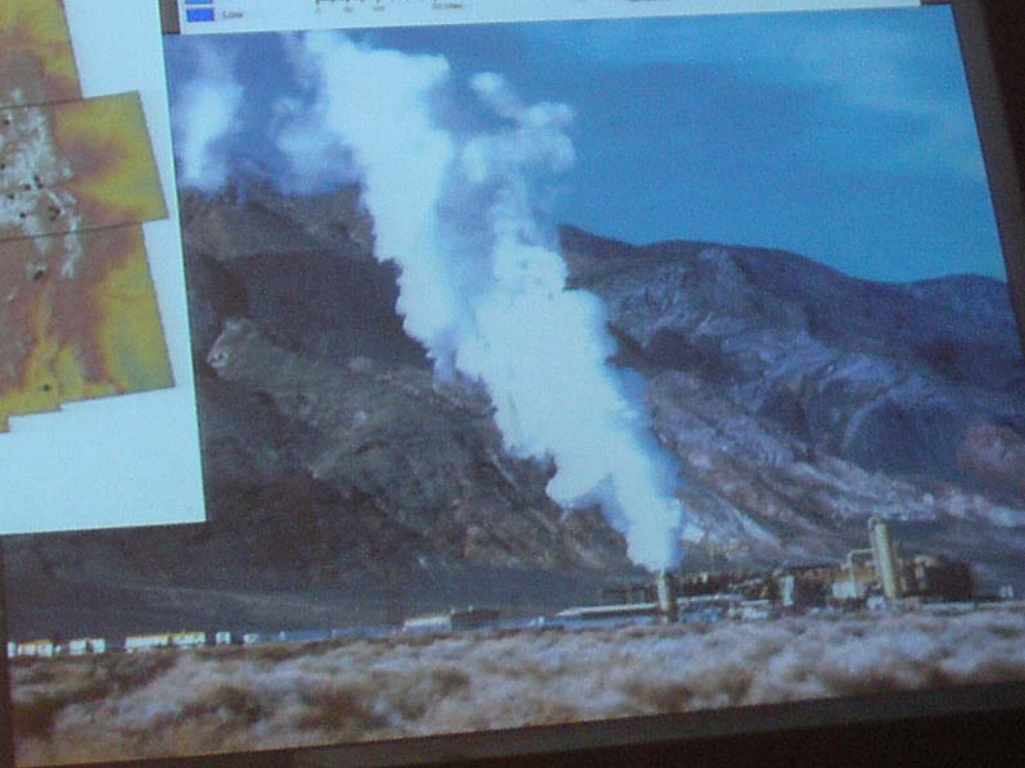
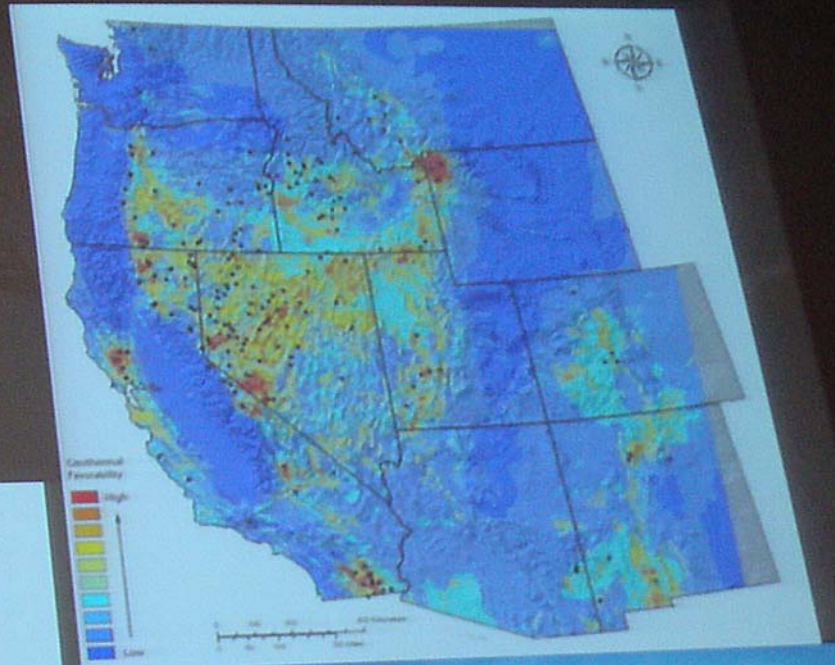
Solar Energy Challenges



Desert tortoise

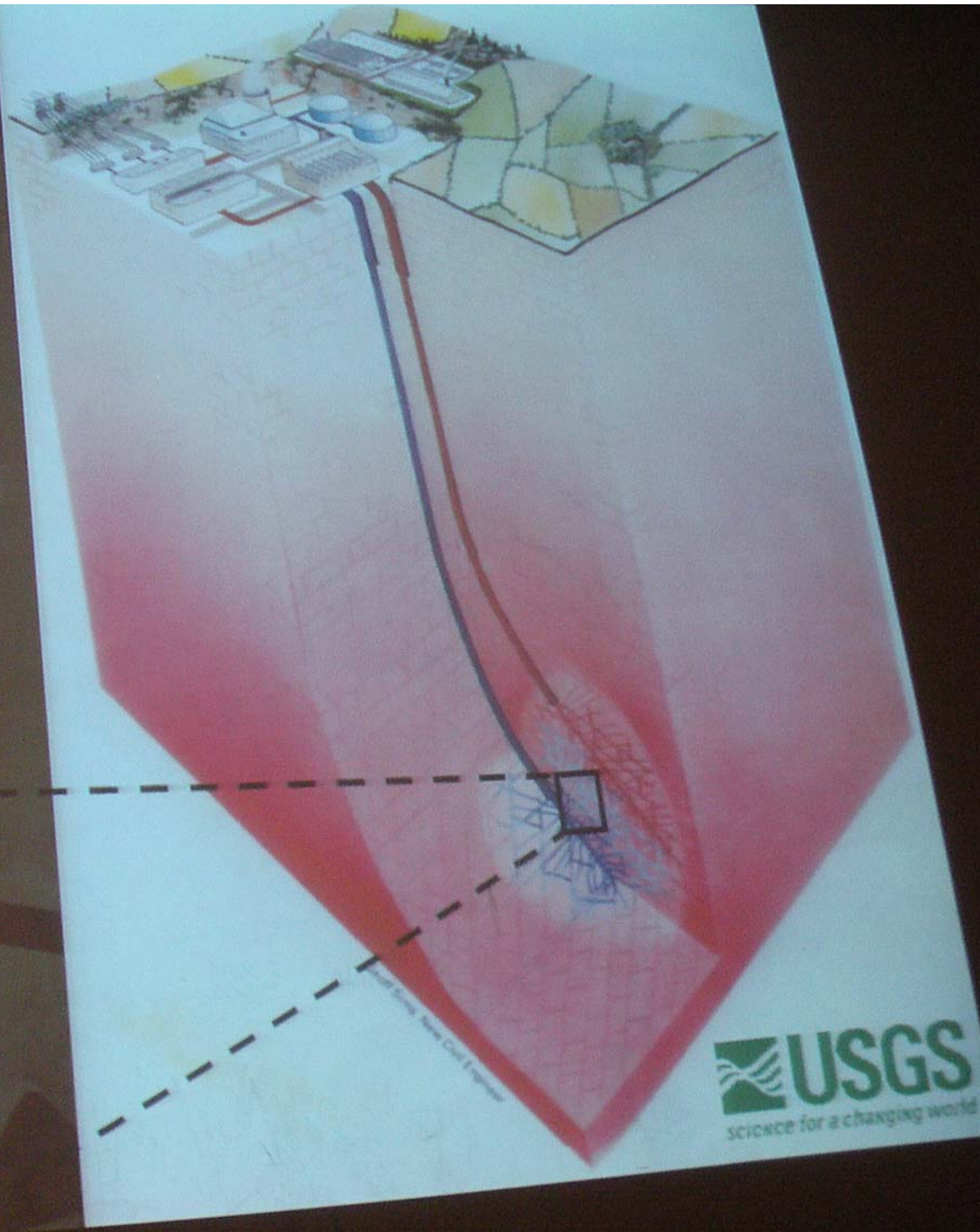
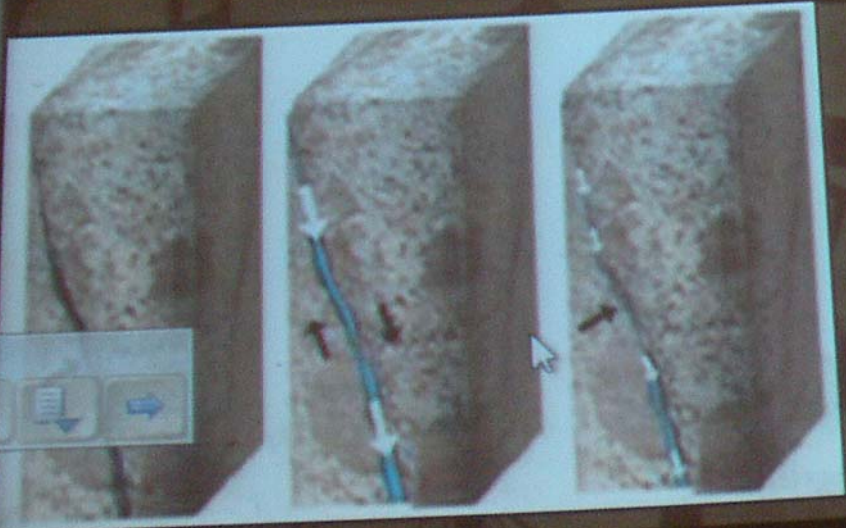
Geothermal Energy

A high-potential renewable energy resource



Enhanced Geothermal Systems (EGS)

Permeability is enhanced by causing existing fractures to slip and propagate or creating new tensile cracks by raising fluid pressure.



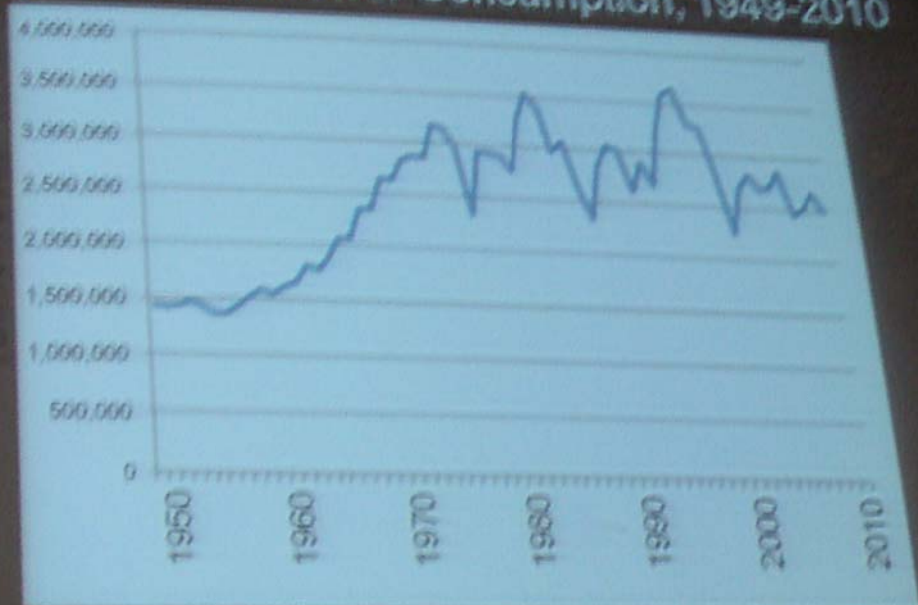
Hydropower

Top Hydropower Producing States, 2010

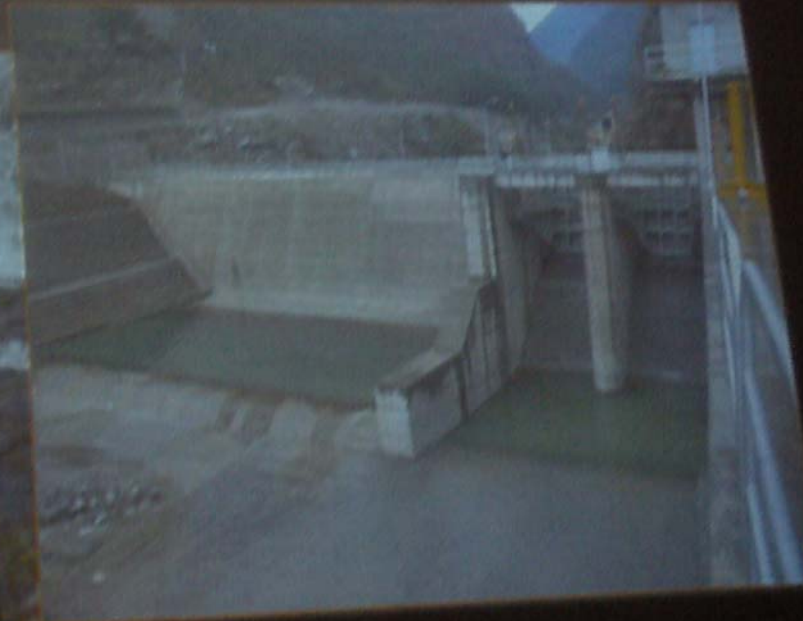


Source: U.S. Energy Information Administration, *Electric Power Monthly*, Table 13.B (March 2011).

U.S. Hydroelectric Power Consumption, 1949-2010

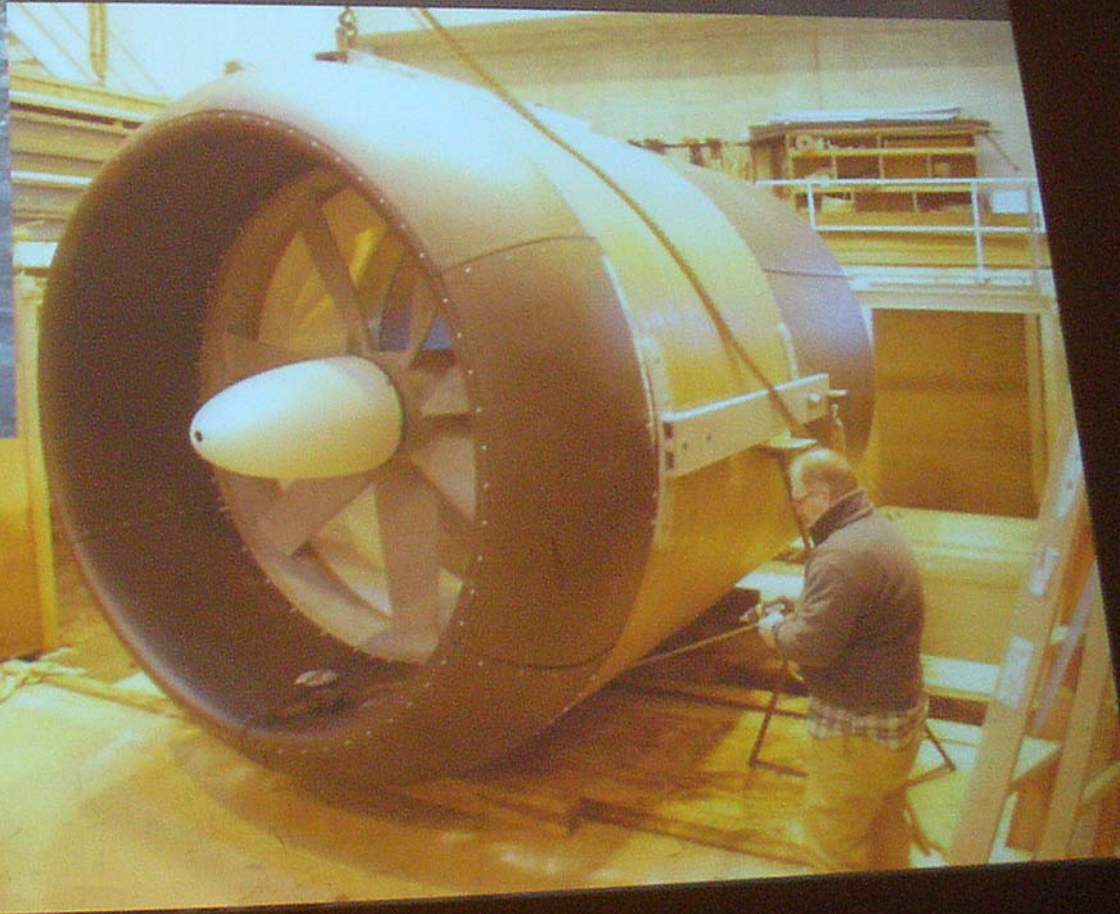
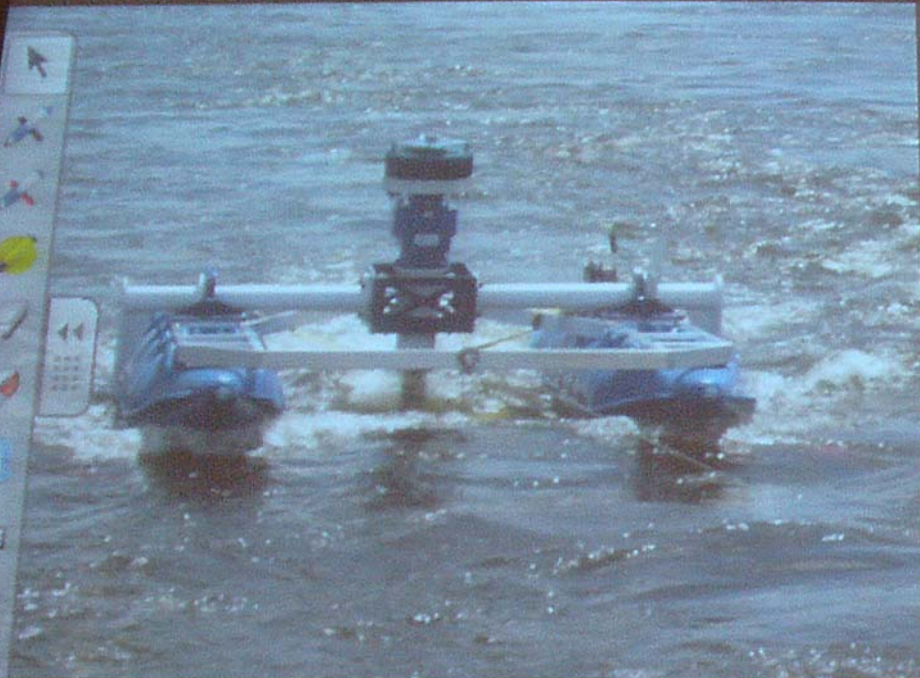


EIA Annual Energy Review 2010



Hydrokinetic energy: potential and challenges

Commercially developed hydrokinetic designs being tested for wildlife impacts at the USGS Conte Anadromous Fish Research Laboratory in Turners Falls, MA.



The USGS is “Energy Policy Neutral”

- Fossil Fuels: resource assessments – how much do we have, and what does it take to extract it?
- Climate Change: What are the impacts? How quickly do we need to adapt to avoid those impacts?
- Environmental Health: What are the consequences of various pollutants released into the environment from burning various fossil fuels on ecosystems, and which cascade to humans?
- Ecosystems: How can we mitigate the impact of renewable energy development on wildlife?
- Hazards: How can we stop induced seismicity associated with energy extraction?



fuels" before
be a losing
ing the more
ating us to
with
ow to
ive energy

EXIT

Handwritten text on a whiteboard, including the letters "A", "B", "C", "D", "E", "F", "G", "H", "I", "J", "K", "L", "M", "N", "O", "P", "Q", "R", "S", "T", "U", "V", "W", "X", "Y", "Z", and some numbers like "14813" and "14814".



we sw
strateg

- The c
unco
devel

- Ren
challe
ass
resp

CSG

