



Toward a Global Geoscience Initiative

Challenges for Solid Earth Science Related to Energy/Climate/Environment/Economy

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Toward a Global Geoscience Initiative

Enormous

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Important

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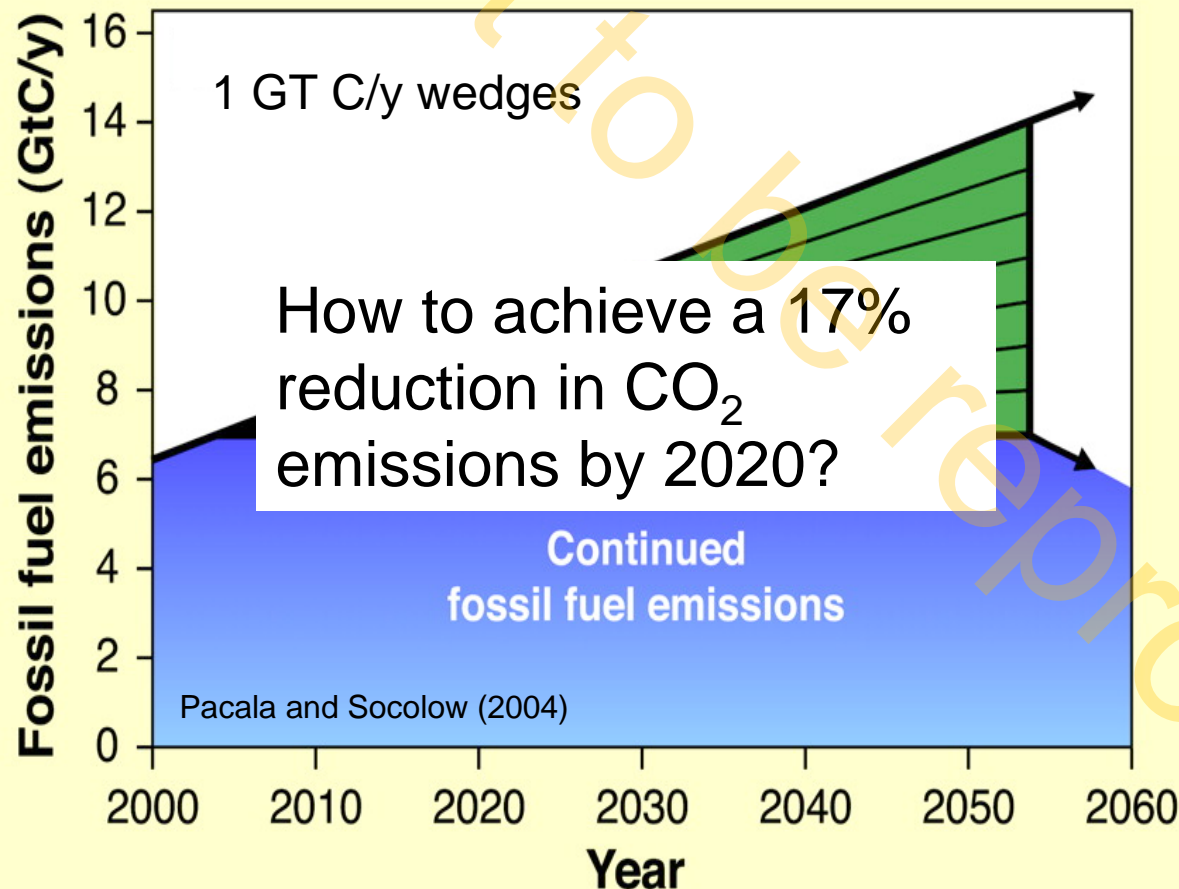
Toward a Global Geoscience Initiative

Immediate

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Strategies for Stabilizing CO₂ Emissions by Mid-Century



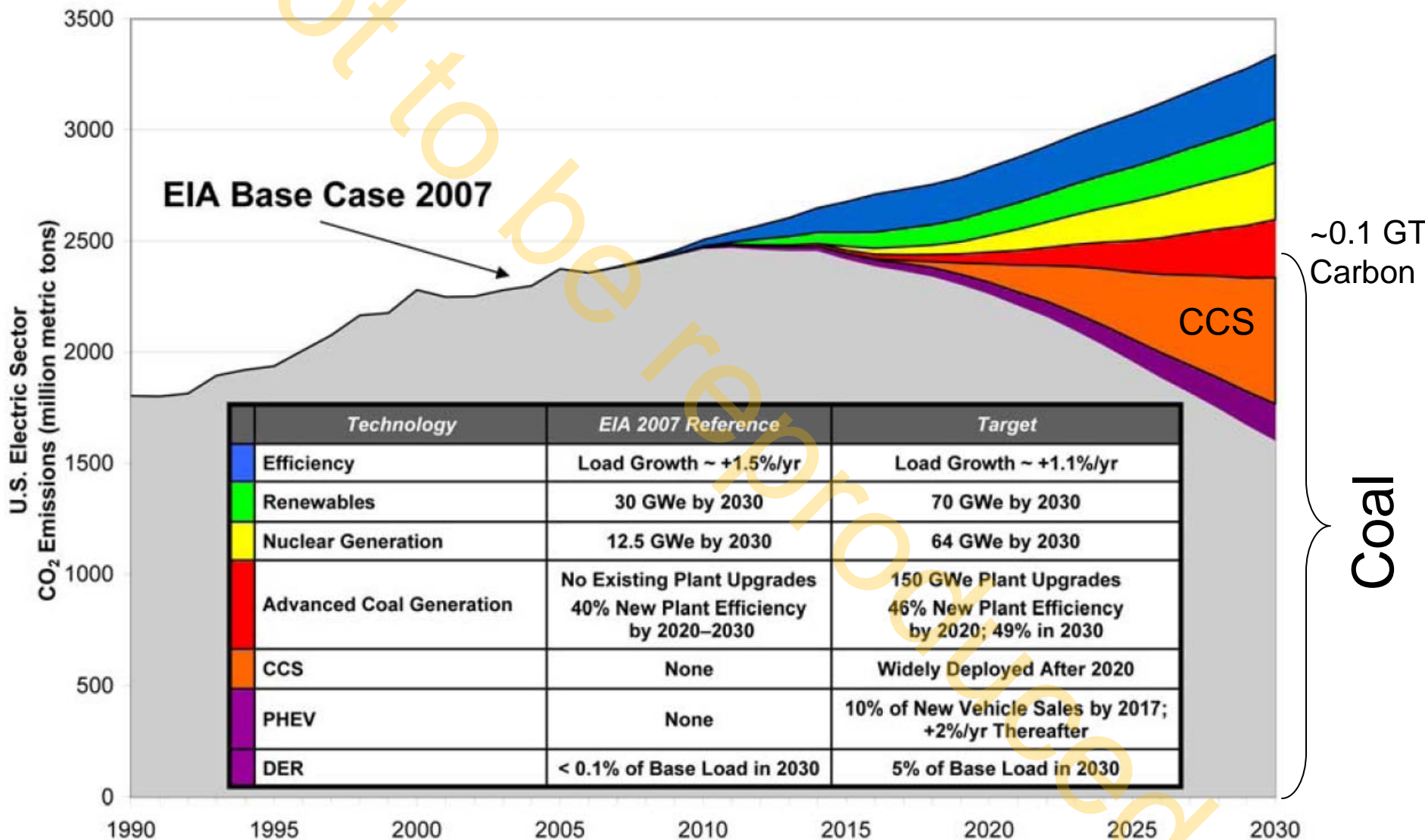
Potential Wedge #6 - CO₂ Capture and Storage (CCS) from coal baseload power generation

Potential Wedge #9 - Use Nuclear to replace coal baseload power

Potential Wedge #5 - Use Gas to replace coal baseload power

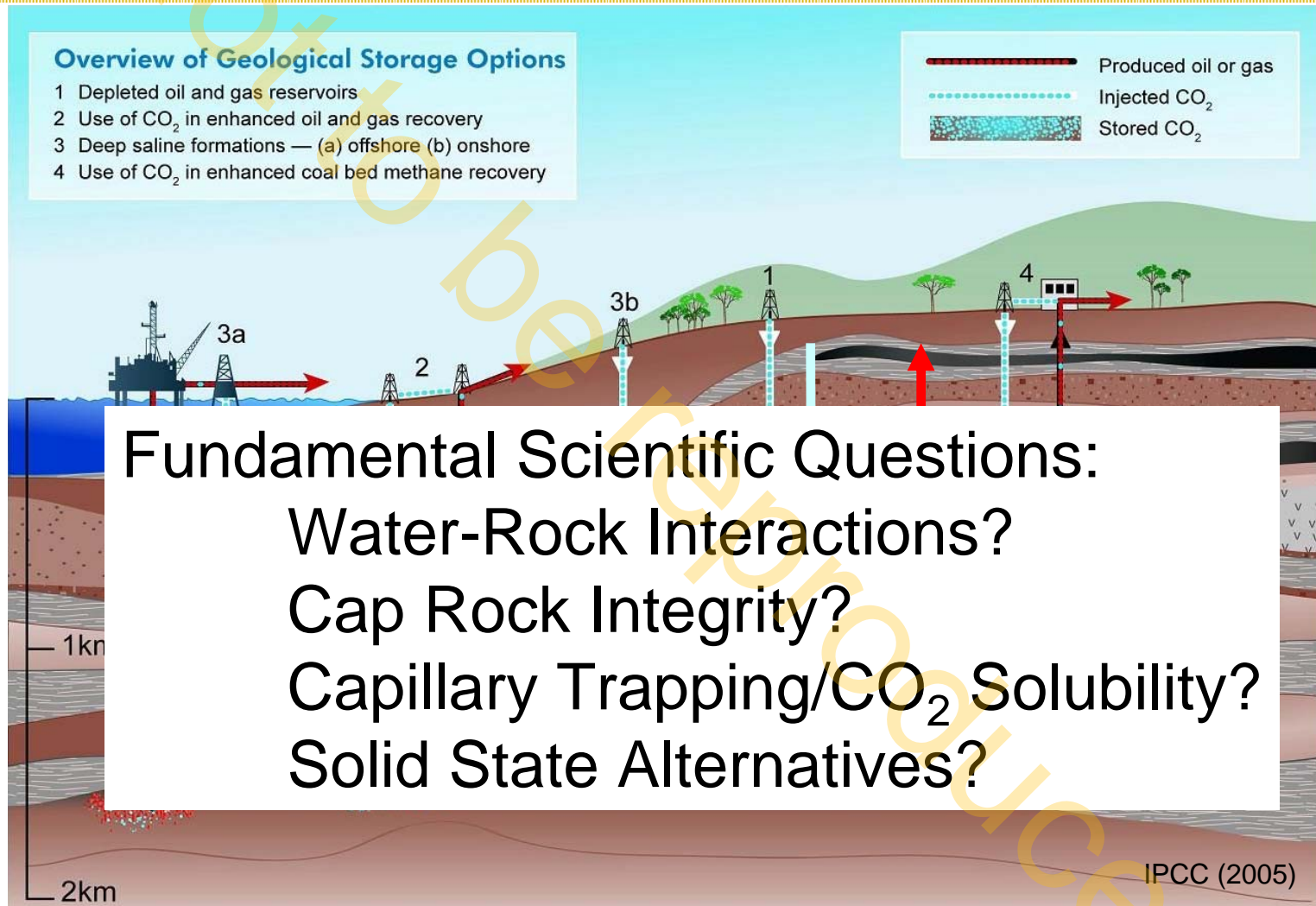
To contribute to stabilization of atmospheric greenhouse gas, each wedge must operate at a scale of ~ 1 GT C/y

Coal/Nuclear/CCS Scenario



Source: EPRI, The Power to Reduce CO₂ Emissions, 2007

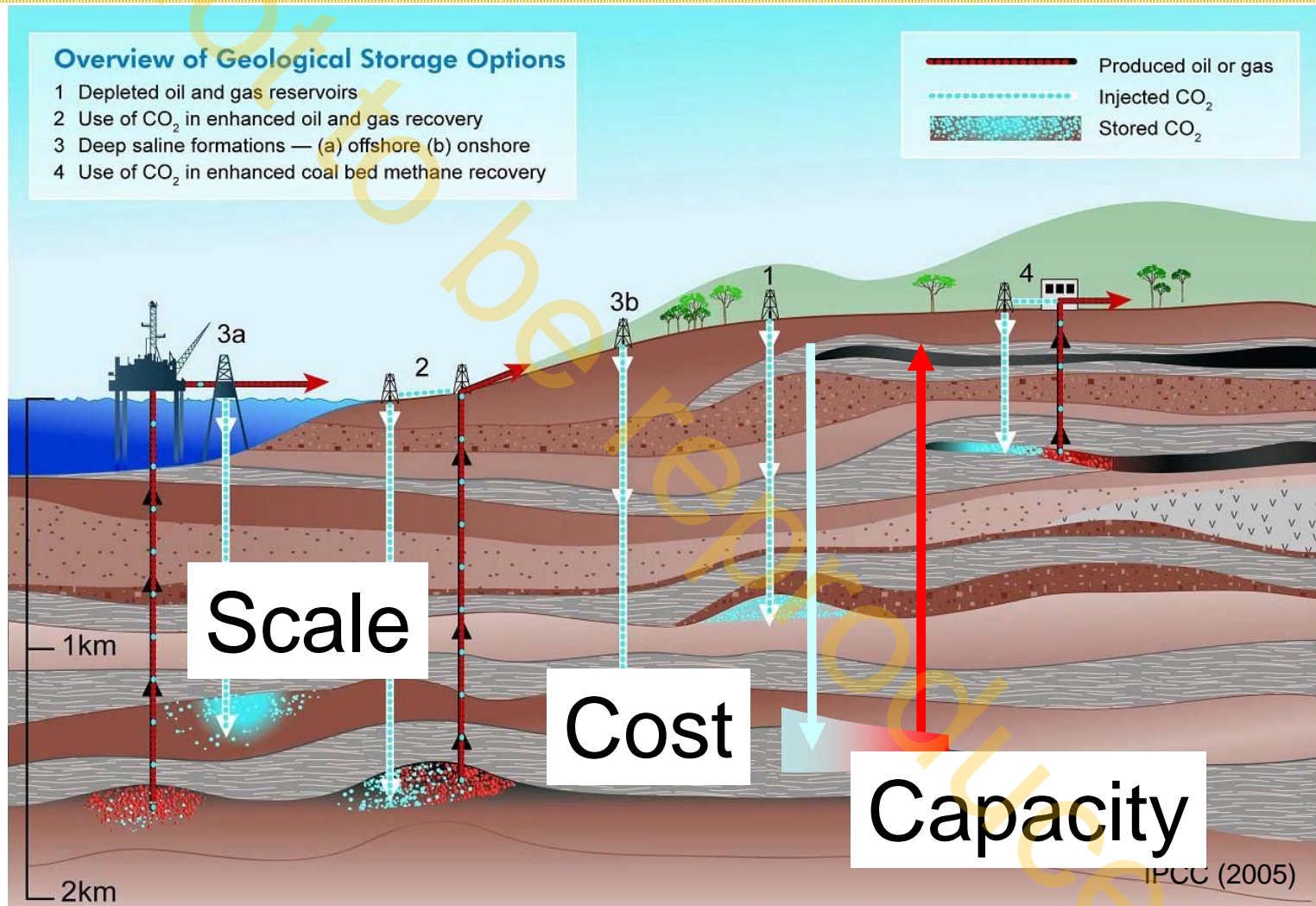
CO₂ Capture and Storage



Fundamental Scientific Questions:
Water-Rock Interactions?
Cap Rock Integrity?
Capillary Trapping/CO₂ Solubility?
Solid State Alternatives?

If CO₂ Sequestration is going to contribute to stabilization of atmospheric greenhouse gas, it must operate at a scale of ~ 1 GT C/y

CO₂ Capture and Storage



If CO₂ Sequestration is going to contribute to stabilization of atmospheric greenhouse gas, it must operate at a scale of ~ 1 GT C/y

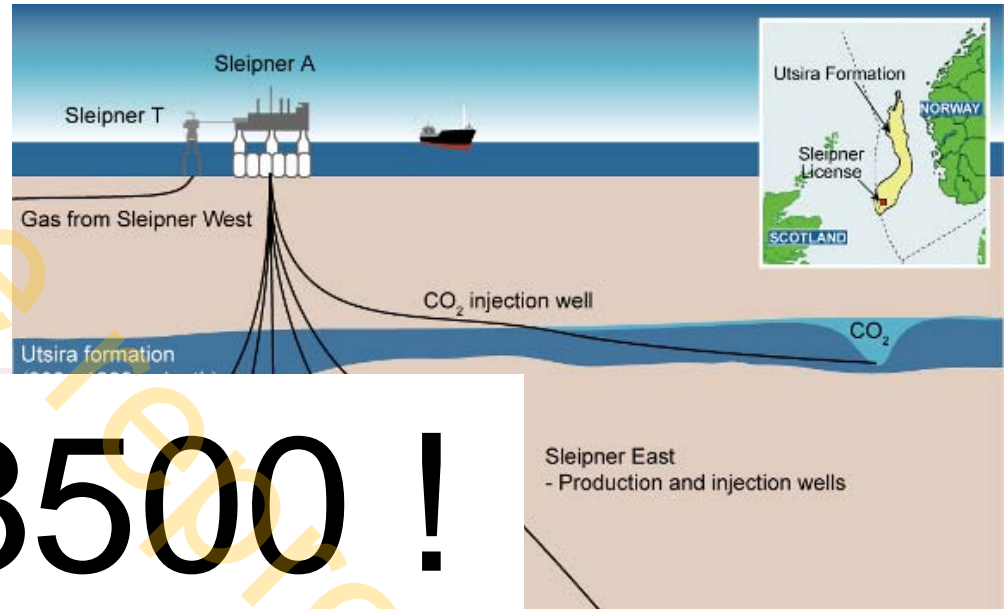
Mass of CO₂ in CCS \approx Oil Production



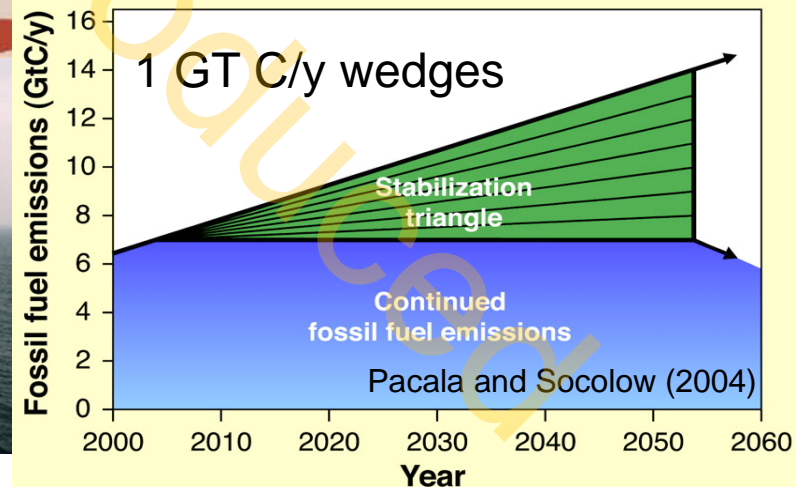
urces: EIA, US Natural Gas Pipeline Network

Why Not Just Do It?

- 1996 to present
- 1 Mt CO₂ injection/yr
- Seismic monitoring



X 3500 !



Capacity and Cost?

AEP Mountaineer Project: New Haven, WV



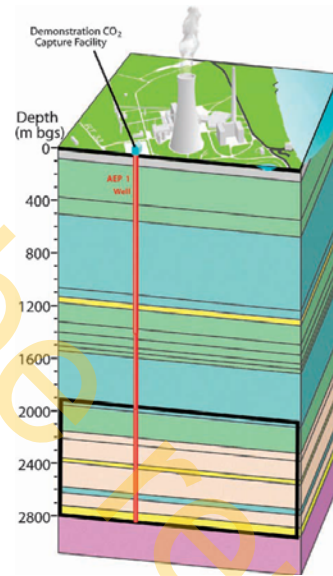
NY Times Sept. 21, 2009

Current Plans to Inject 100 ktons/y for 2-5 years

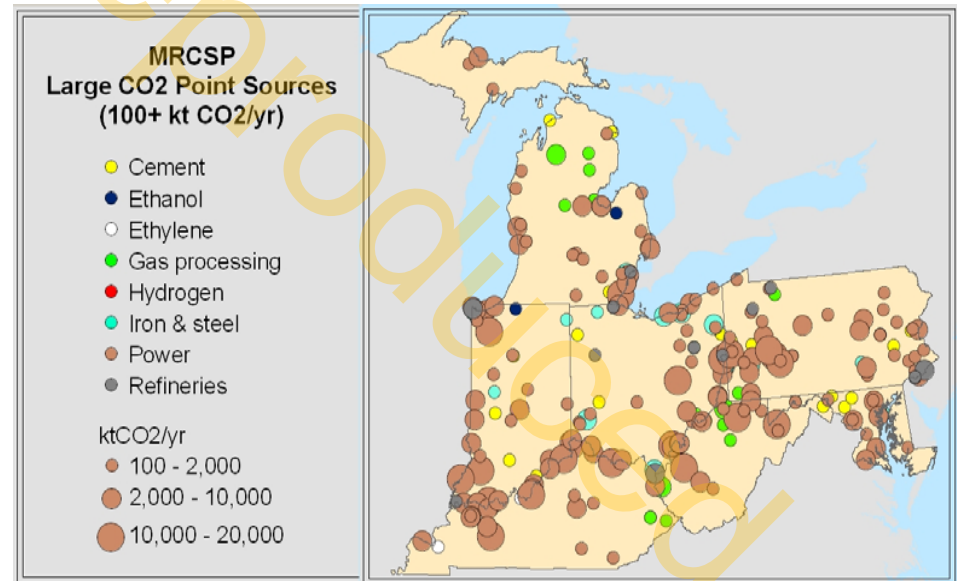
AEP Mountaineer Project: New Haven, WV



AEP Mountaineer
CO₂ Emissions ~7
Mton/year limited to
~ 35 kton/year per
injection zone - 200
injection zones
required!



183 Coal burning
plants in Ohio
River Valley
(emitting 700
Megatons of
CO₂/year)

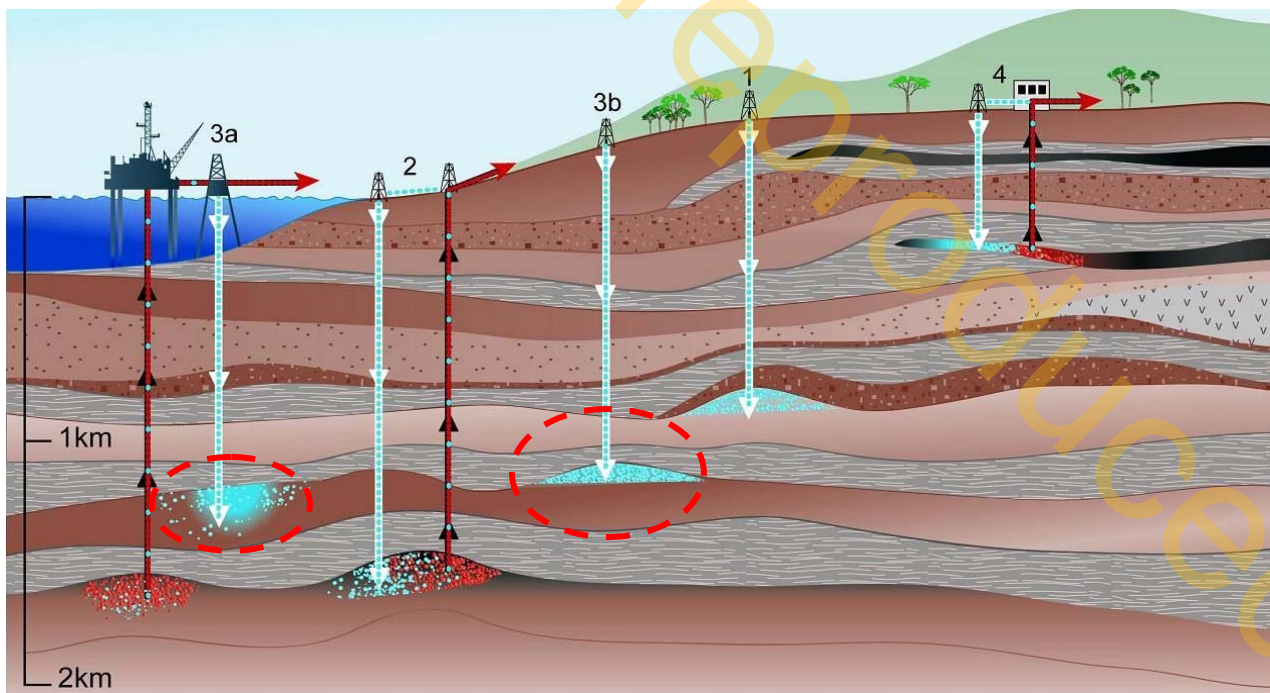


Cost

- Energy penalty: 10 to 30%
- Cost
 - \$50 to \$100/tonne CO₂ for the nth plant
 - Significantly more for the 1st plants (\$150 to \$250/tonne CO₂)
 - Cost of electricity generation: 50 to 100% increase
- Uncertain reliability

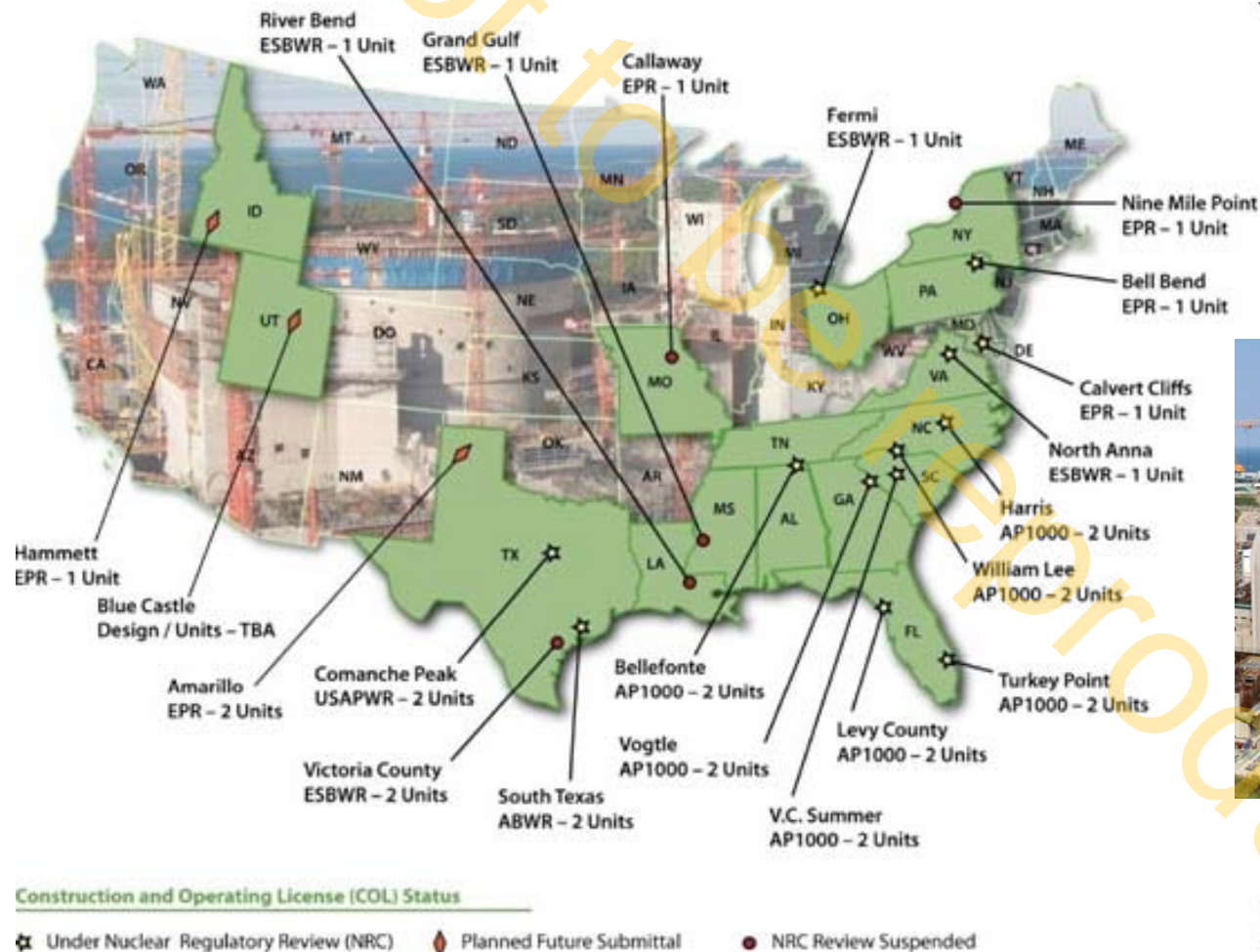
Revisiting Overly Optimistic World Wide Capacity Estimates

Reservoir Type	Lower Estimate of Global Storage Capacity (GtCO ₂)	Upper Estimate of Global Storage Capacity (GtCO ₂)
Oil and gas fields	675	900
Coal seams (ECBM)	3–15	200
Saline aquifers	1000	~ 10,000



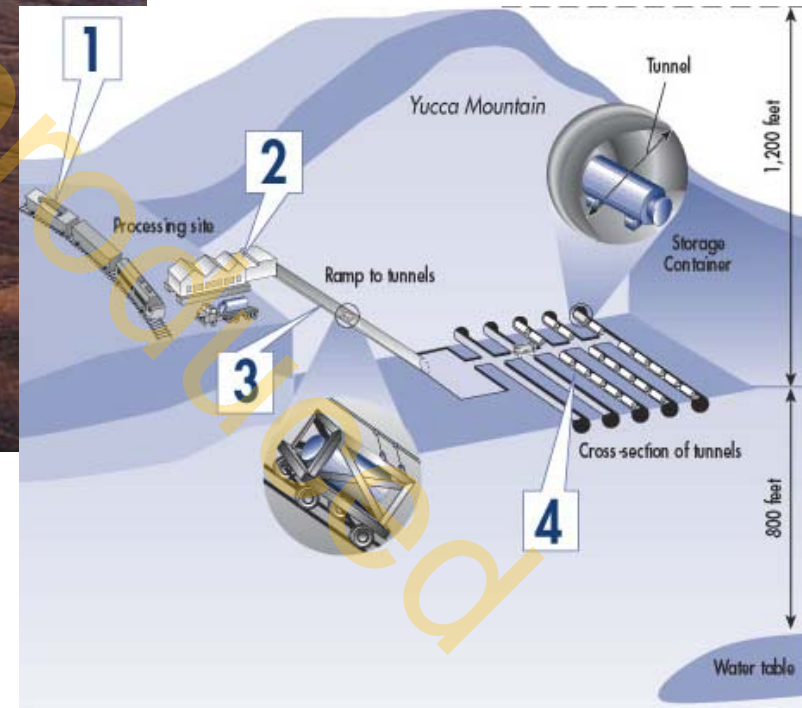
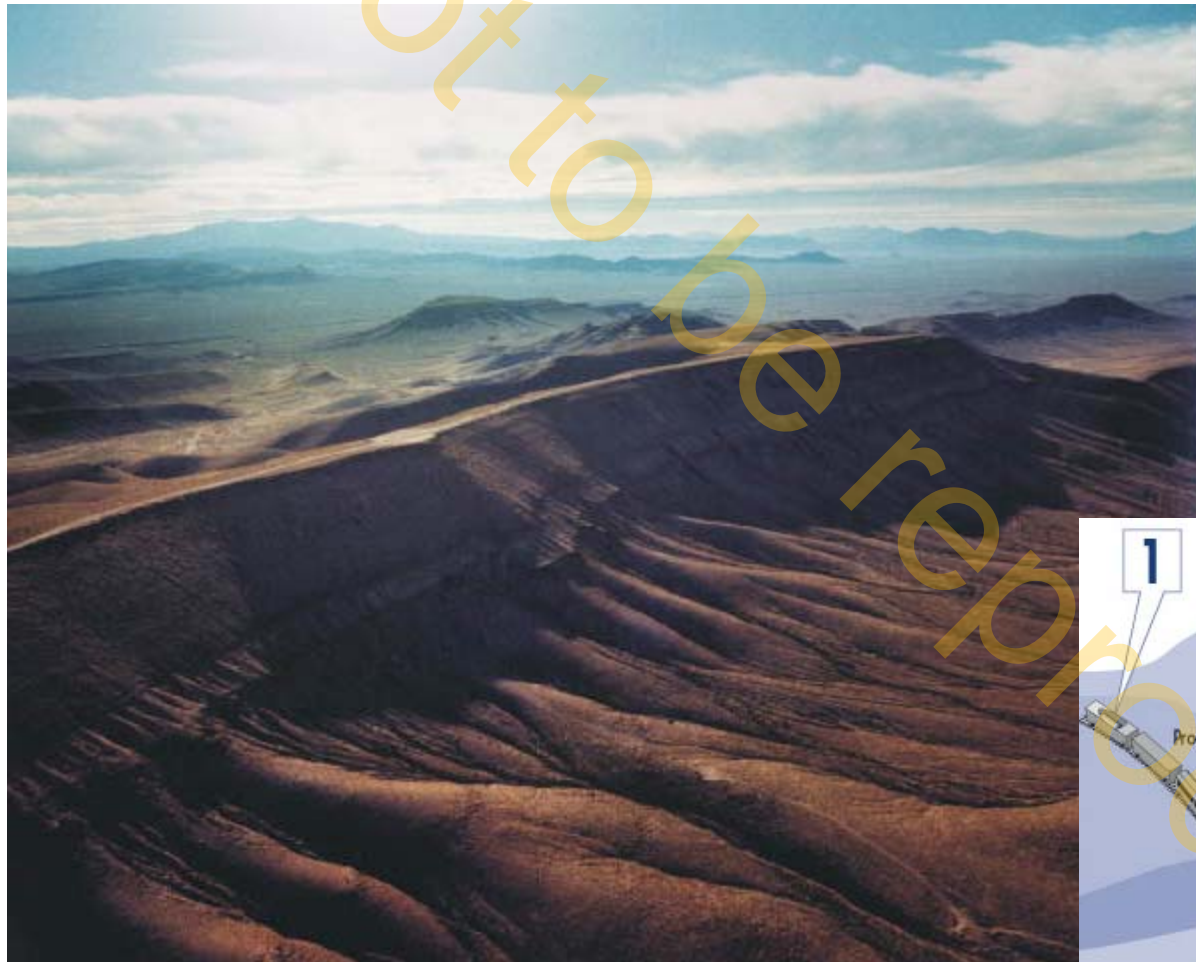
IPCC, 2005

50 New Nuclear Power Plants by 2030?

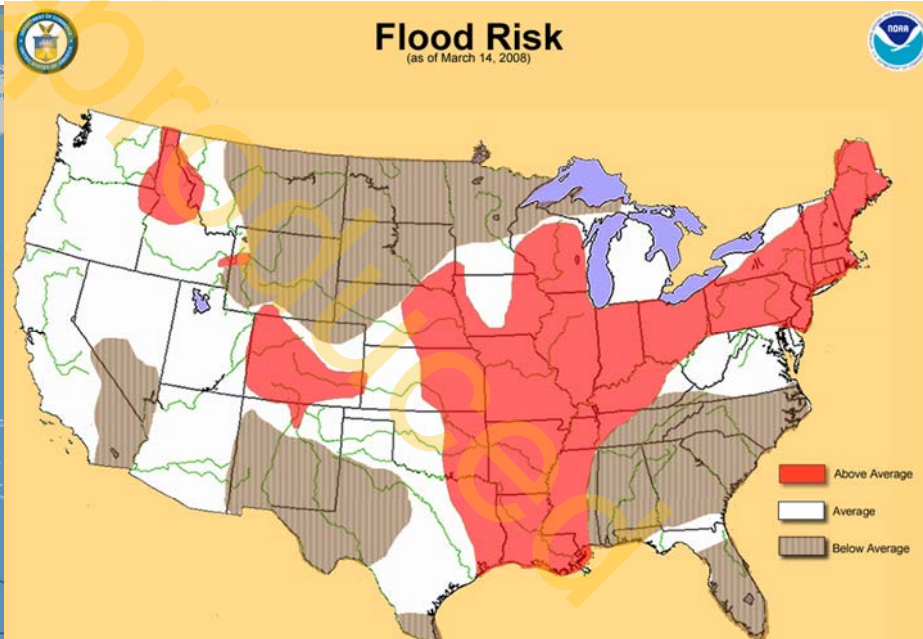
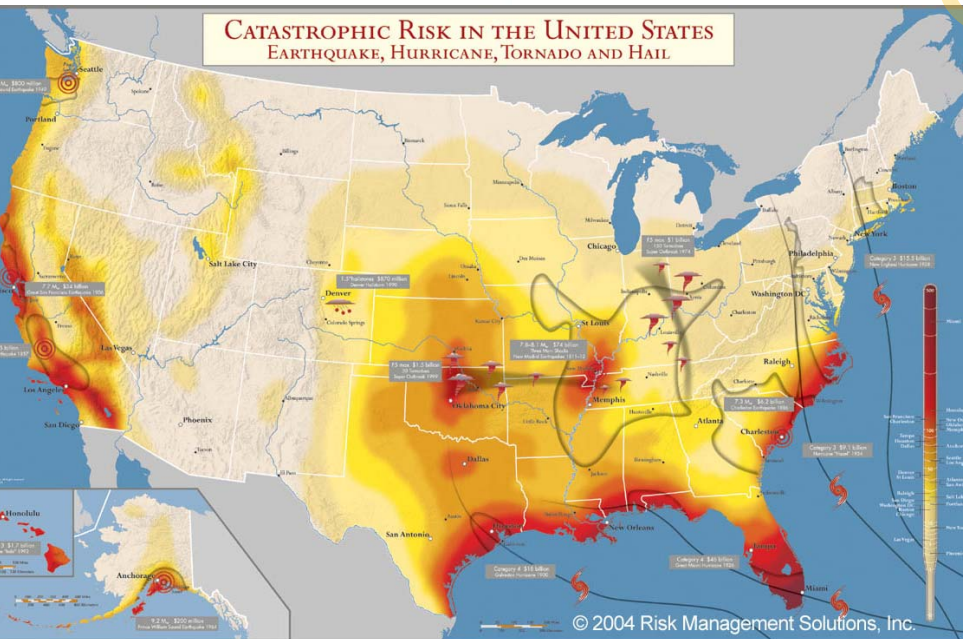
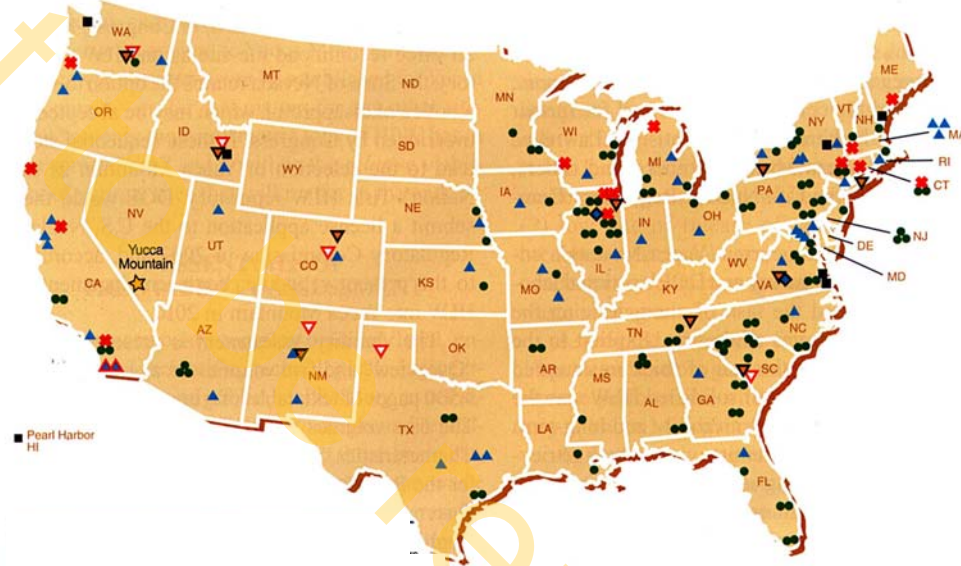


Licensing Will be a Formidable Task that Will Take Effort and Time

Waste Disposal After Yucca Mountain?



Surface Waste Storage and Other Natural Hazards



Fuel Switching to Reduce CO₂ Emissions

Natural Gas Produces Half the CO₂ per BTU

Current Gas Power Electrical Generation Capacity 400 GW

Current Average Utilization ~20%

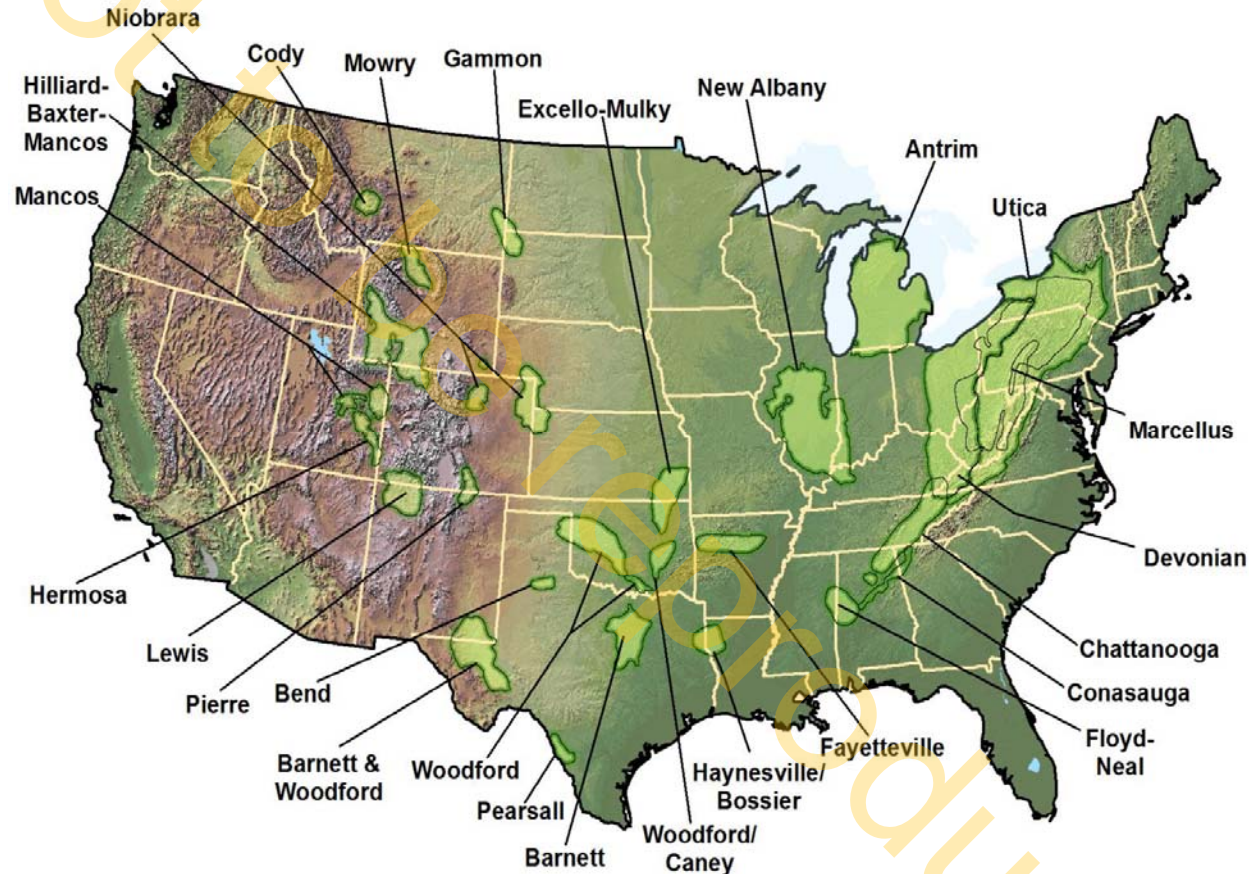
To Meet CO₂ Reduction Targets for 2020,
Need to Increase Utilization of Existing
Plants to ~40%

(Could Also Replace Oldest and Least
Efficient Coal Plants with Combined-Cycle
Gas Plants)



Combined-Cycle Gas Plant

Unconventional Gas Resources

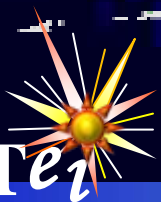


2009 Estimates of Gas Resources Over 2000 TCF
~100 Years at Current Consumption

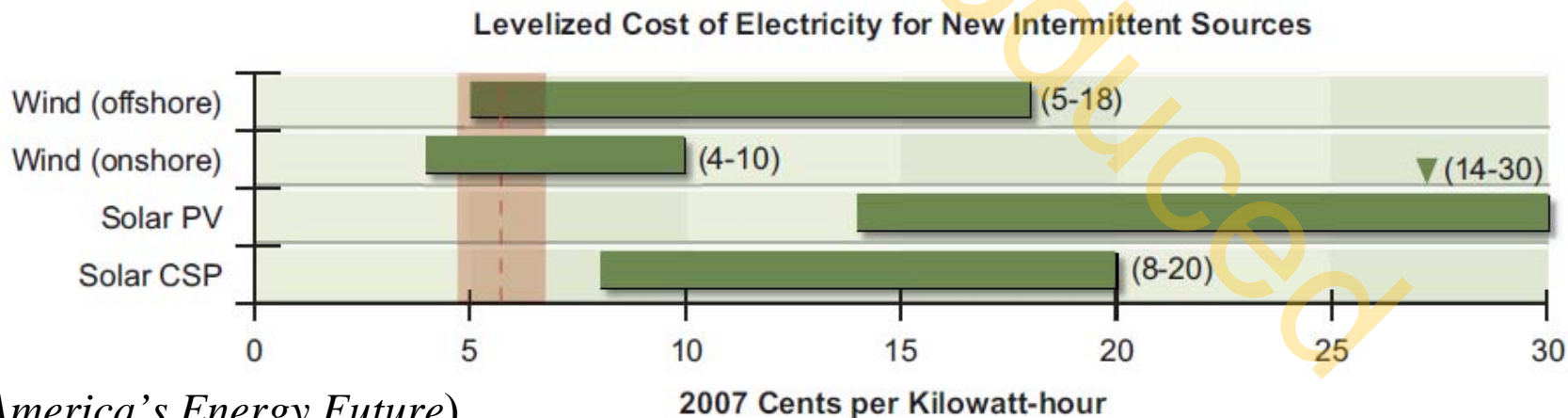
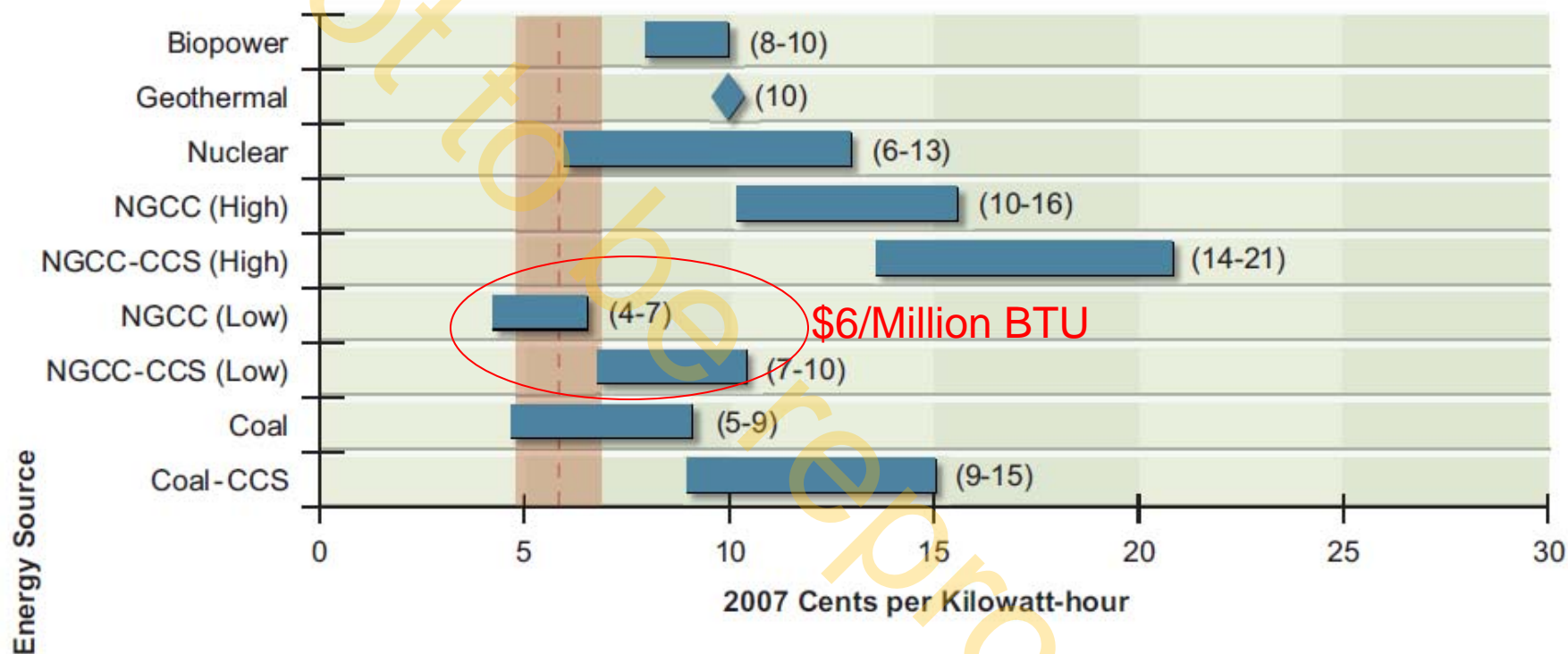
Global Potential for Shale Gas



World Total: 32,560 tcf
roughly 300 years of supply



Inexpensive (and stable) Gas Prices



Many Challenges Remain

Optimize the Resource

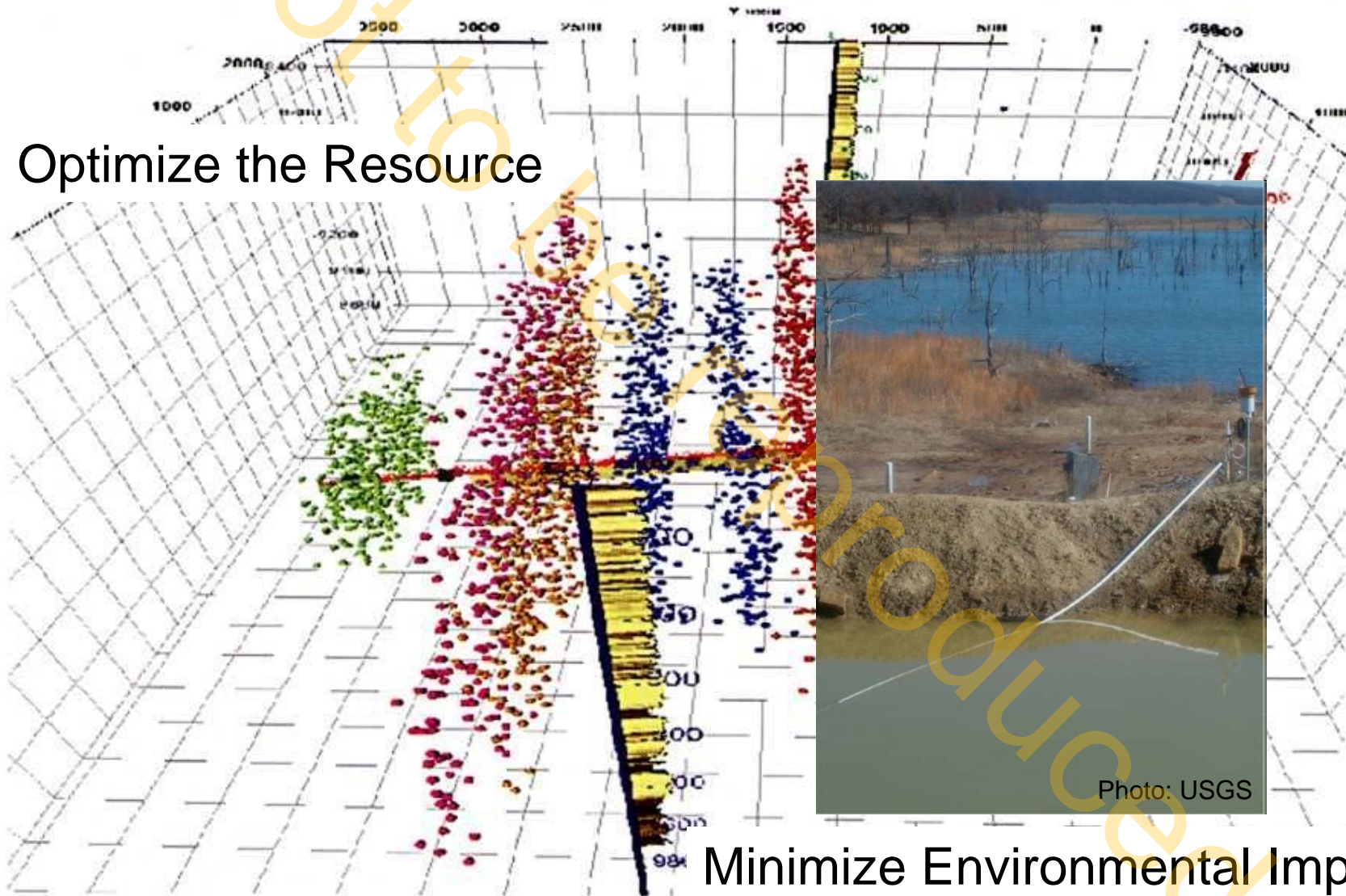


Photo: USGS

Minimize Environmental Impact



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