

Challenges of Deploying Carbon Capture & Storage (CCS) Technologies

G8-IEA-CSLF
Workshop on Near Term Opportunities
for Carbon Capture and Storage

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Existing Coal Use for Power Generation



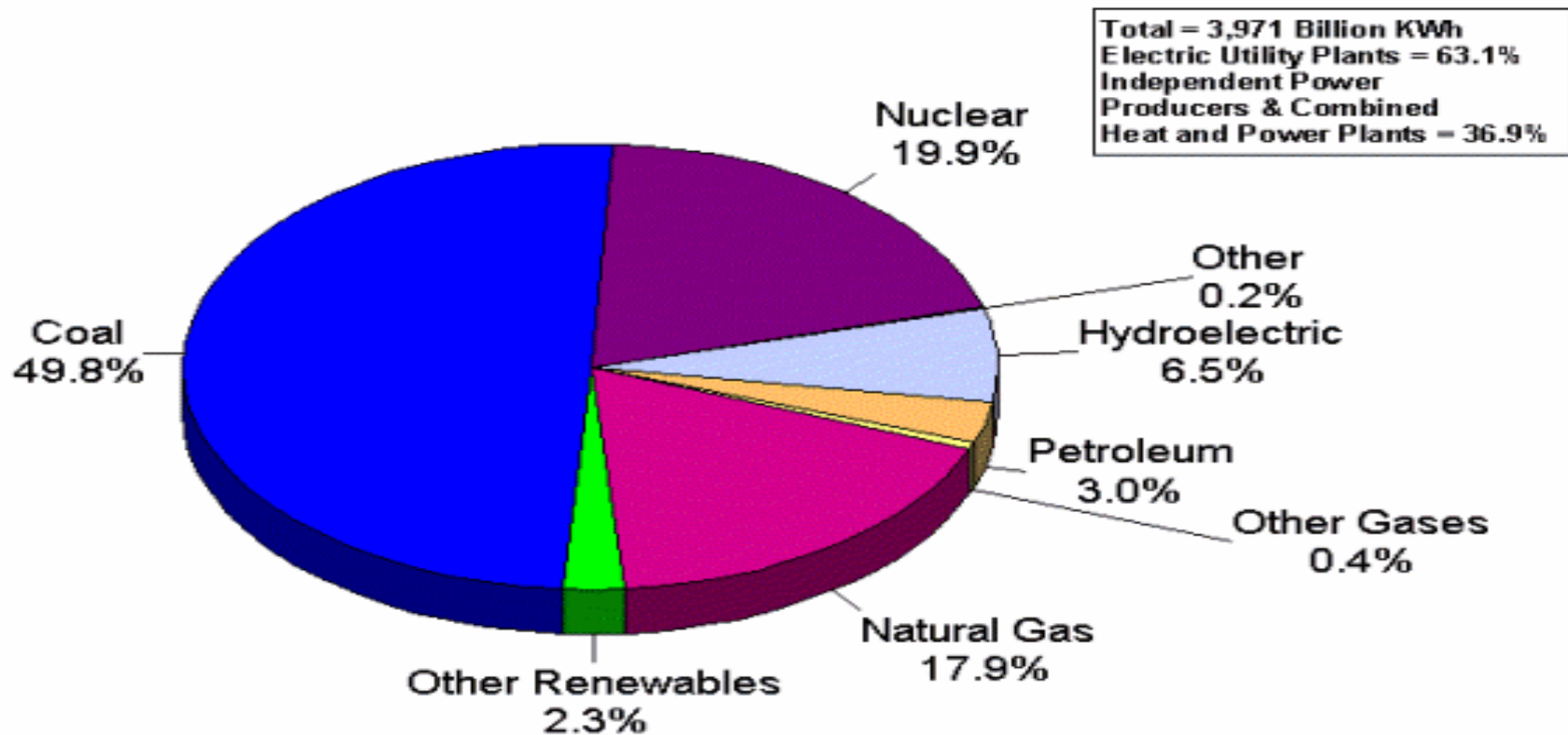
Existing U.S. Capacity by Energy Source

(U.S. Energy Information Administration, 2006)

<u>Energy Source</u>	<u>Number of Generators</u>	<u>Generator Nameplate Capacity (megawatts)</u>
Coal	1,526	335,243
Natural Gas	3,048	256,627
Nuclear	104	105,560
Hydroelectric Conventional	3,995	77,130
Other	8,097	275,056
Total	16,770	1,049,616

Electric Power Generation by Fuel Type

(U.S. Energy Information Administration, 2006)



Note: Conventional hydroelectric power and hydroelectric pumped storage facility production minus energy used for pumping.

Net Generation by Energy Source by Type of Producer

(U.S. Energy Information Administration, 2006)

Year	Coal	Natural Gas	Nuclear	Hydroelectric Conventional	Other	Total (Thousand Megawatt hours)
2004	1,978,620	708,979	788,528	268,417	226,011	3,970,555

Sources & Sinks

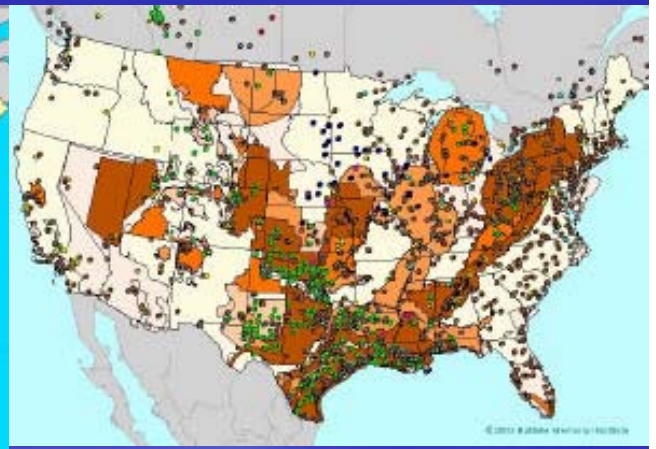
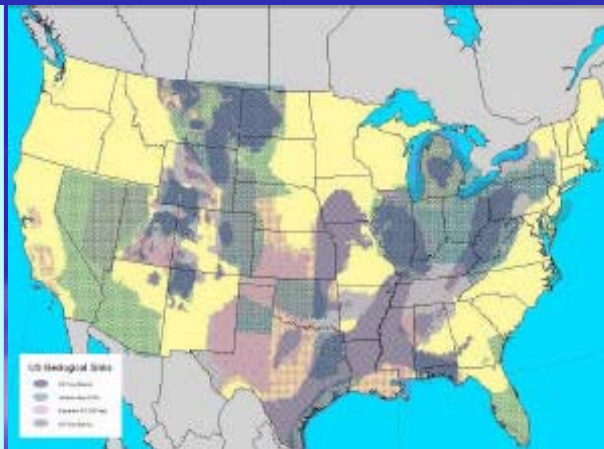


United States: *Large CO₂ Storage Resource and Large Potential Demand for CO₂ Storage* (source: Battelle)

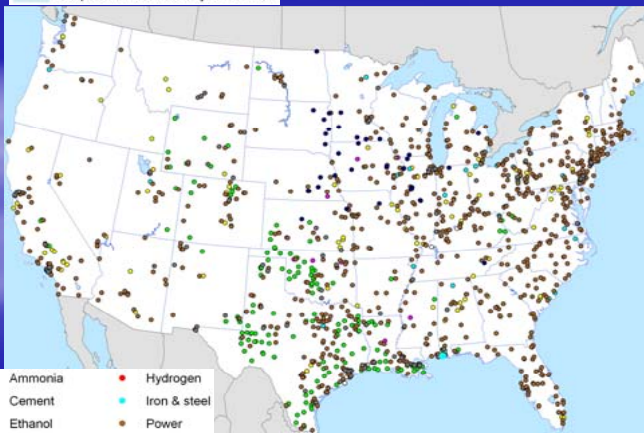
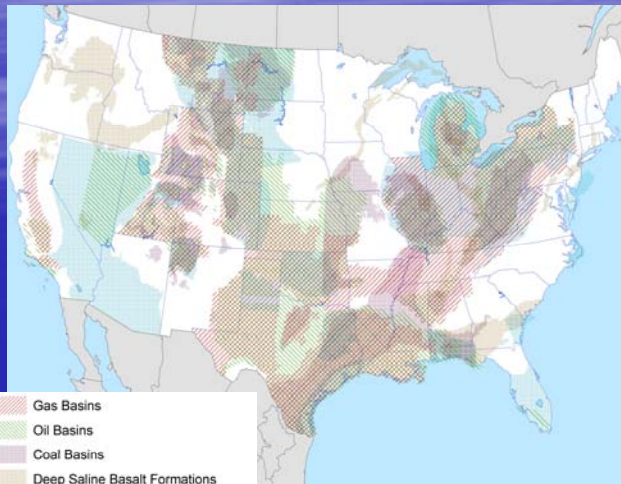
Thousands of
Potential
Industrial & Power
Plant Users

Hundreds of
Potential
Geologic
Storage
Reservoirs

Decades of
Demand on
Finite Reservoirs



United States: *Large CO₂ Storage Resource and Large Potential Demand for CO₂ Storage* (source: Battelle)



3,900+ GtCO₂ of potential storage capacity

Represents a very valuable and very large natural resource for addressing climate change

Candidate CO₂ storage formations underlie parts of 45 states and two-thirds of the land mass of the contiguous 48 states

Capable of storing the United States' current CO₂ emissions from large stationary point sources for hundreds of years to come

The 500 largest CO₂ point sources in the USA

Are overwhelmingly coal-fired power plants

Represent trillions of dollars of productive industrial infrastructure

Account for 82% of annual emissions from large stationary CO₂ point sources

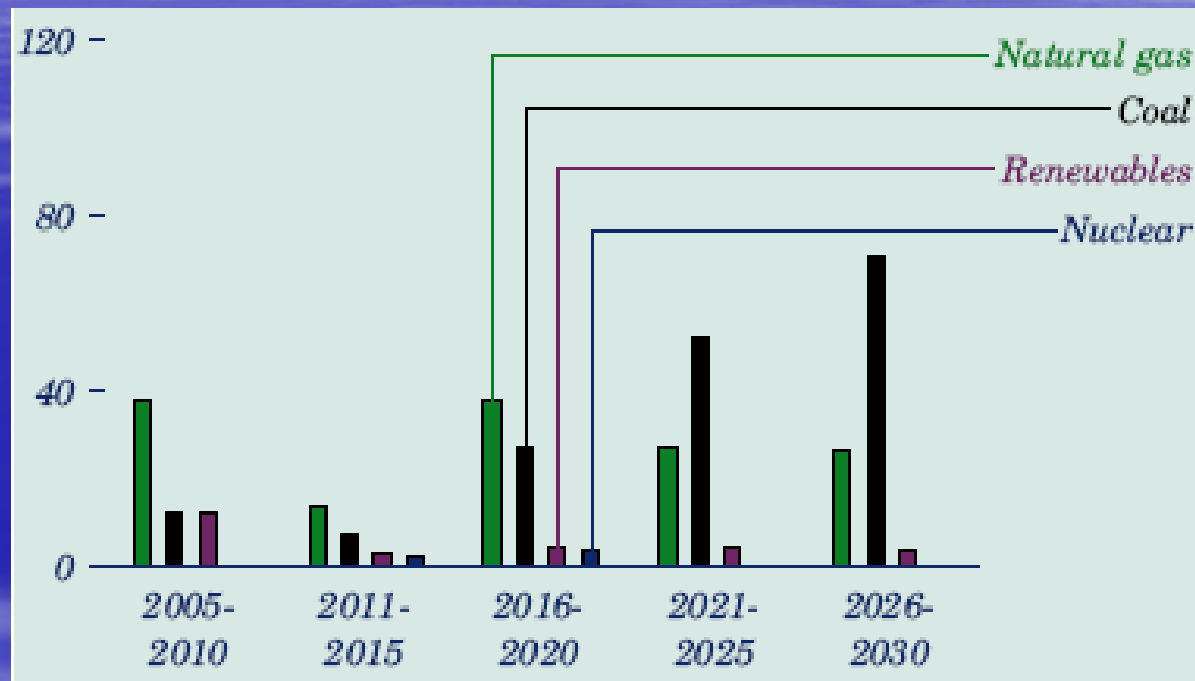
Fully 95% of these facilities have nearby access (i.e., within 50 miles) to at least one candidate geologic storage reservoir

New Capacity Additions



Early Capacity Additions Use Natural Gas; Coal Plants Added Later

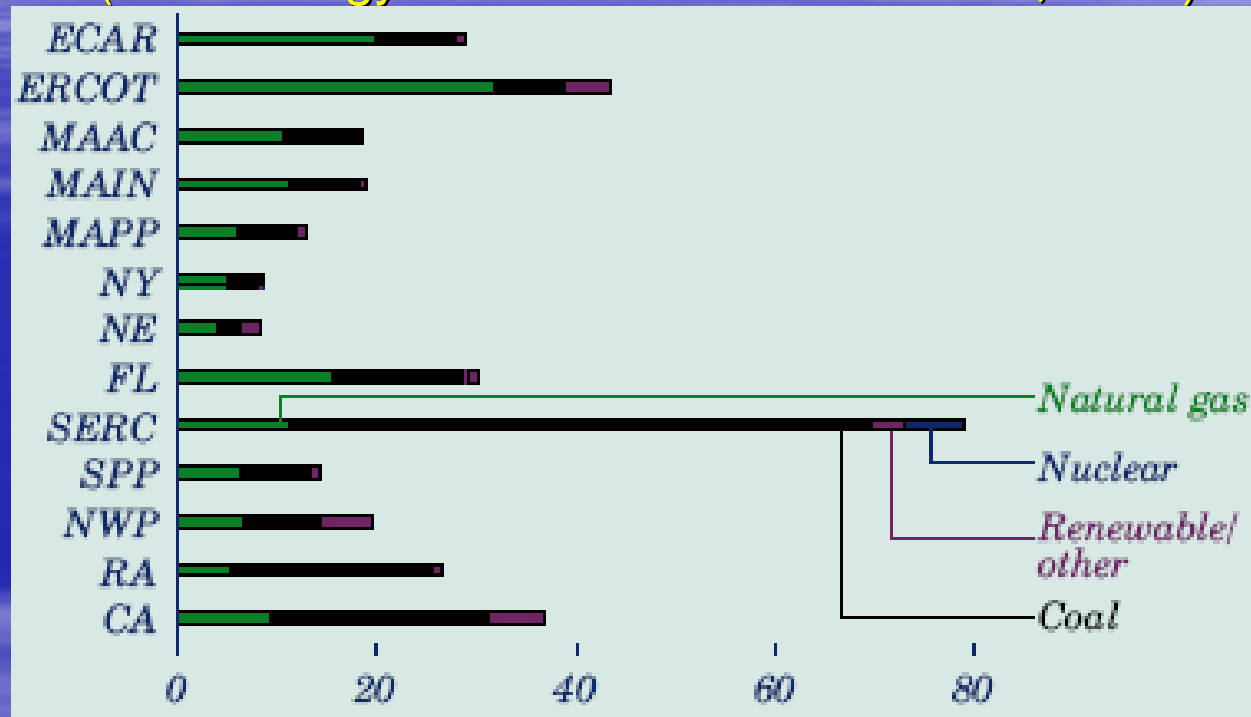
(U.S. Energy Information Administration, 2006)



- Coal-fired and natural-gas-fired plants account for 50% and 40%, respectively, of the U.S. capacity additions from 2004 - 2030

Capacity Additions Are Expected to Be Required in All U.S. Regions

(U.S. Energy Information Administration, 2006)

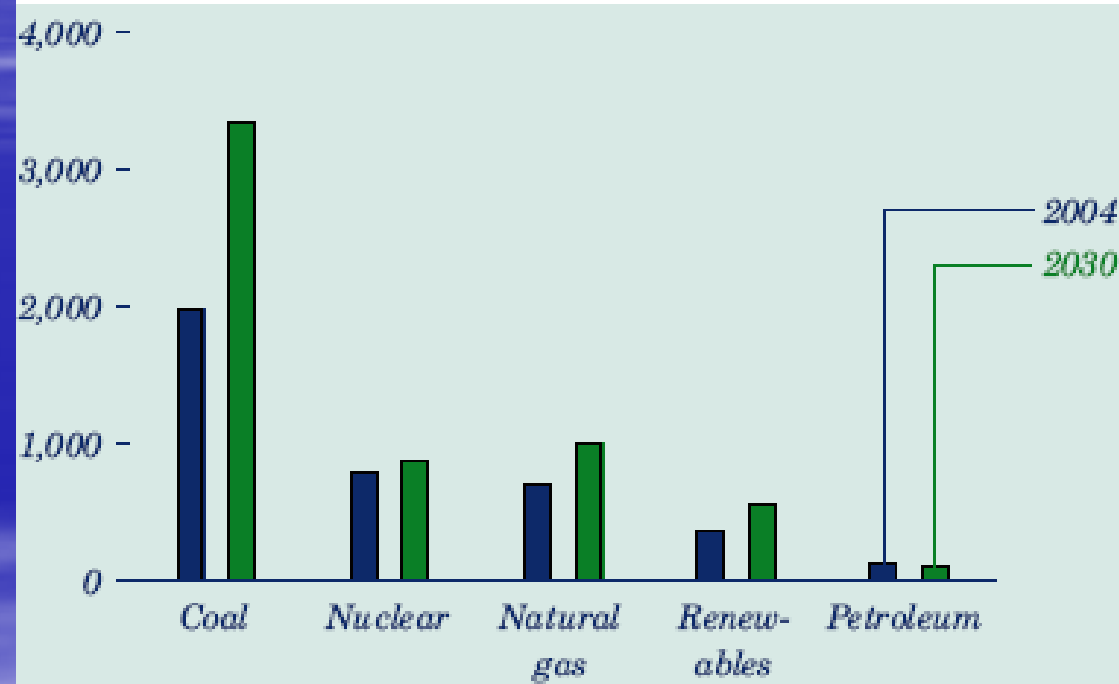


- As natural gas prices rise, coal-fired plants make up most of the capacity additions through 2030
- Largest concentrations of new plants in Southeast and West

Natural Gas and Coal Meet Most Needs for New Electricity Supply in U.S.

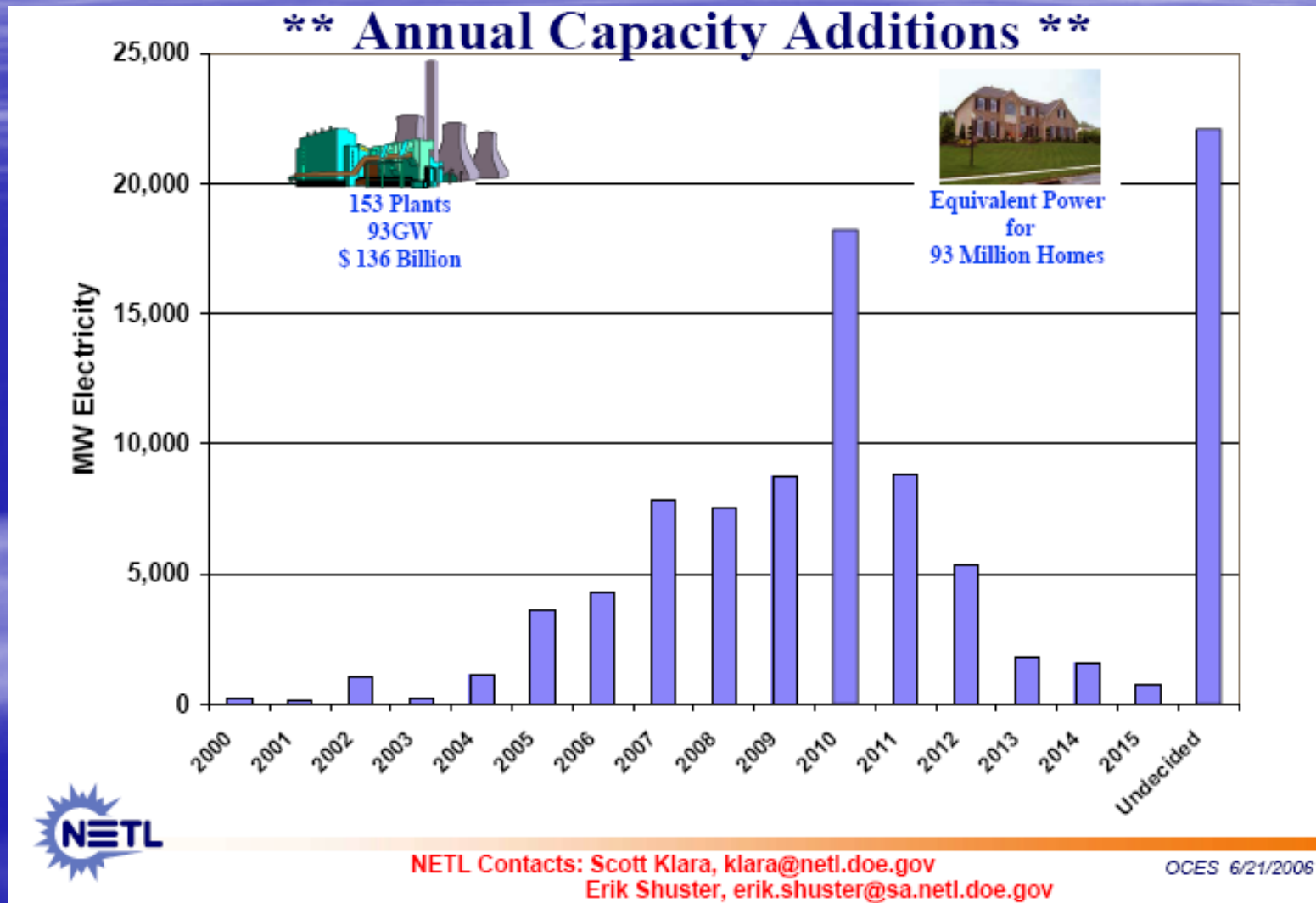
(U.S. Energy Information Administration, 2006)

Figure 62. Electricity generation by fuel, 2004 and 2030 (billion kilowatthours)

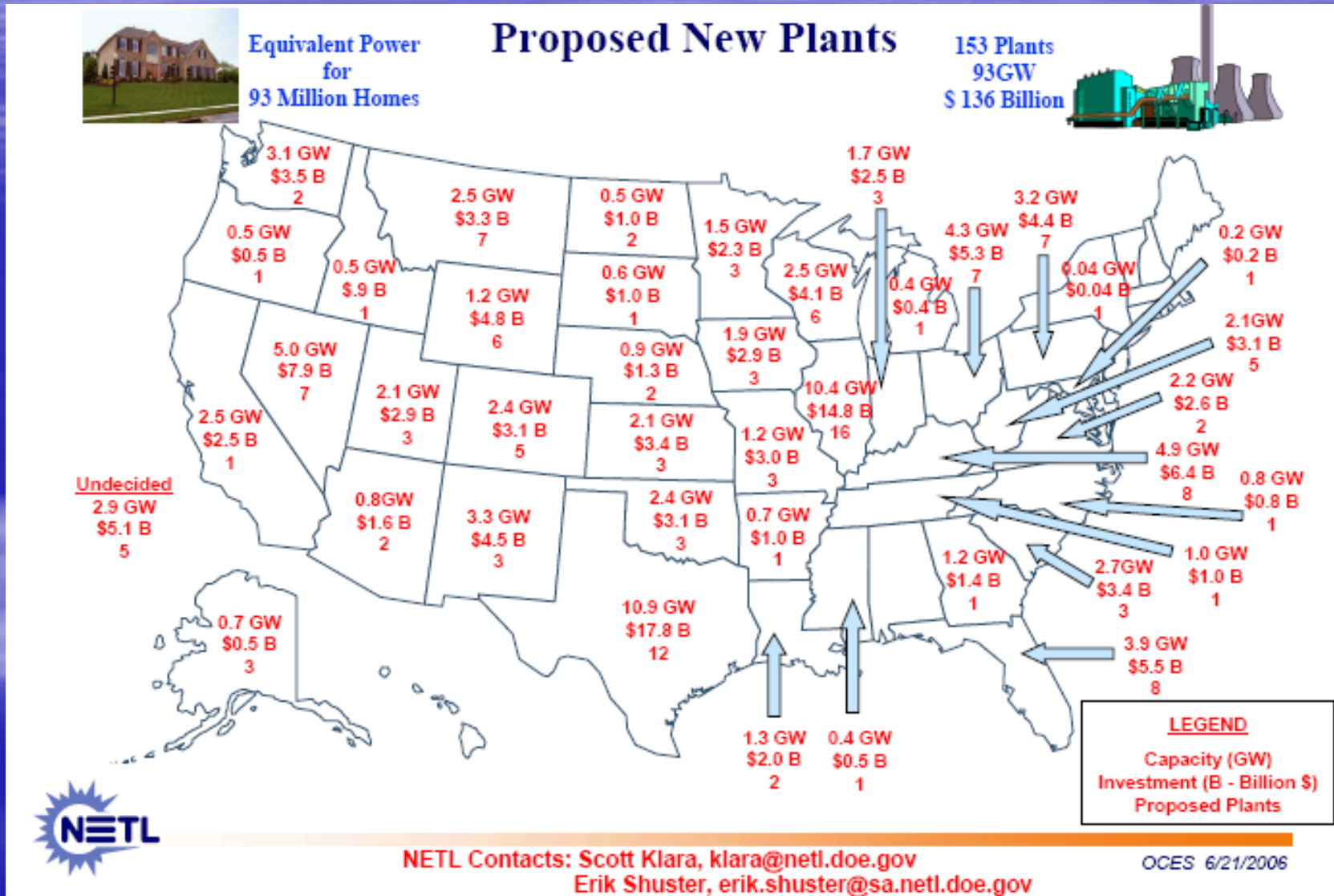


- Coal-fired plants accounted for 50% of all electricity generation in 2004, and their share increases to 57% in 2030.

Coal's Resurgence in Electric Power Generation (NETL, 2006)



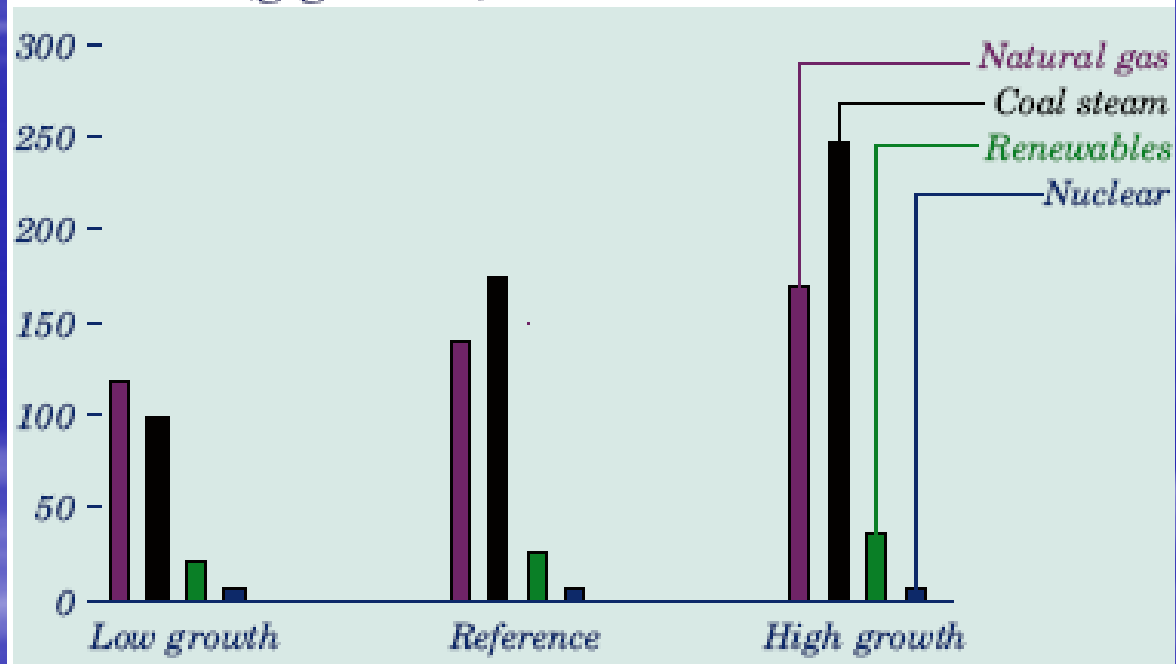
Coal's Resurgence in Electric Power Generation (NETL, 2006)



Faster Economic Growth Stimulates Capacity Additions, Especially Coal

(U.S. Energy Information Administration, 2006)

Figure 67. Cumulative new generating capacity by technology type in three economic growth cases, 2004-2030 (gigawatts)

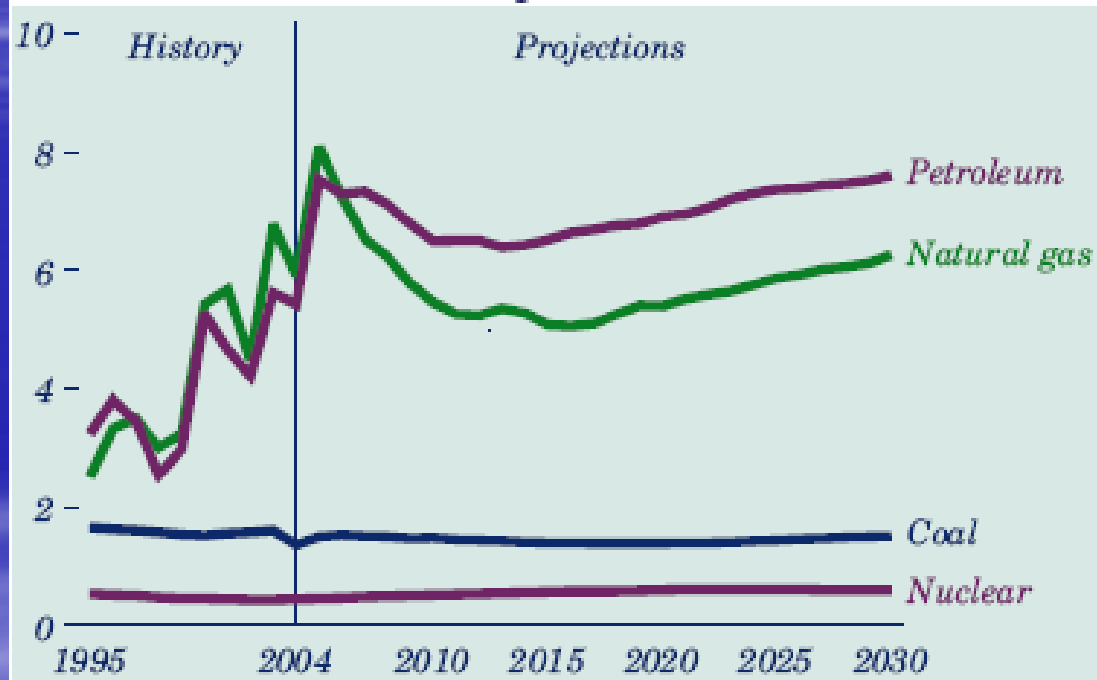


- 65% of capacity added in *high economic growth* instances consists of new coal-fired plants

Fuel Costs Drop from Recent Highs, Then Increase Gradually

(U.S. Energy Information Administration, 2006)

Figure 65. Fuel prices to electricity generators, 1995-2030 (2004 dollars per million Btu)



- After 2015, natural gas and petroleum prices rise steadily, and power producers increase reliance on lower-priced coal.

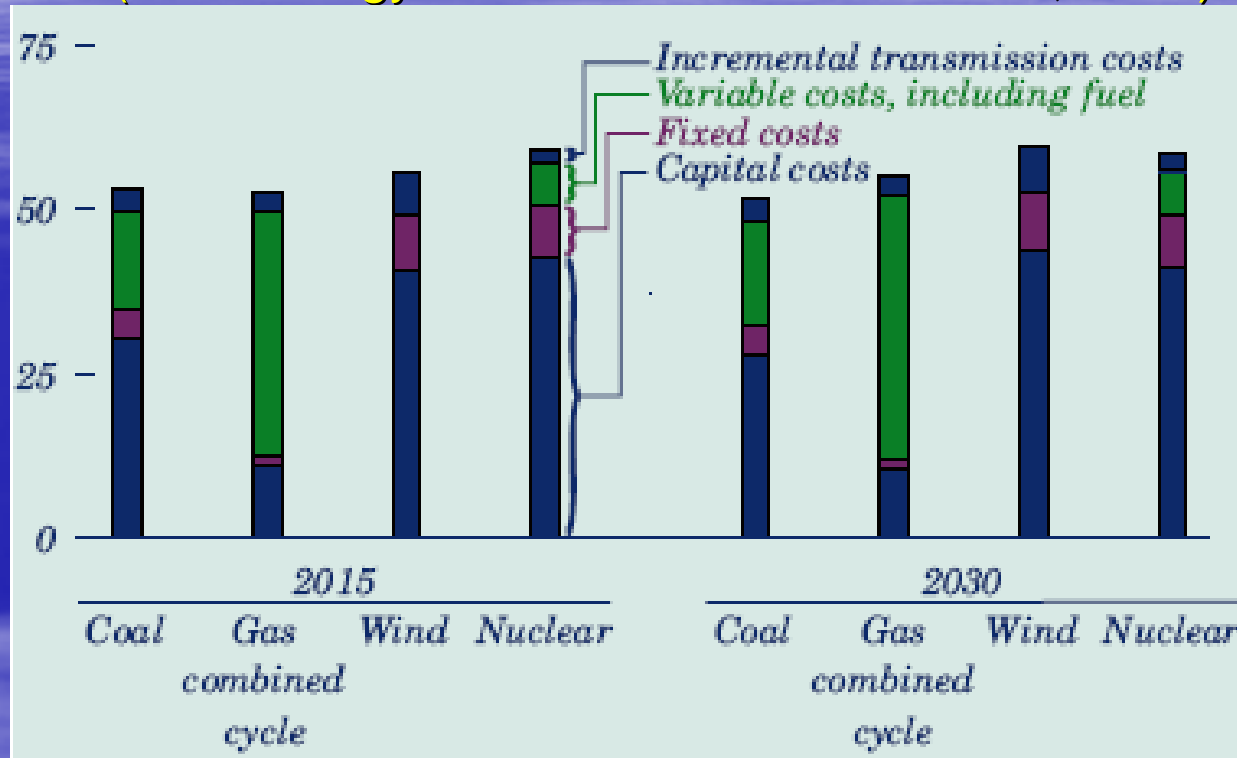
Costs of Producing Electricity from New Plants, 2015 and 2030

(U.S. Energy Information Administration, 2006)

<i>Costs</i>	<i>2015</i>		<i>2030</i>	
	<i>Advanced coal</i>	<i>Advanced combined cycle</i>	<i>Advanced coal</i>	<i>Advanced combined cycle</i>
	<i>2004 mills per kilowatthour</i>			
<i>Capital</i>	30.34	11.33	27.78	10.76
<i>Fixed</i>	4.73	1.40	4.73	1.40
<i>Variable</i>	14.58	36.97	15.82	40.18
<i>Incremental transmission</i>	3.47	2.88	3.40	2.94
<i>Total</i>	53.12	52.58	51.73	55.28

Least Expensive Technology Options Are Likely Choices for New Capacity

(U.S. Energy Information Administration, 2006)



- Technology choices for new generating capacity are made to minimize cost while meeting emissions standards – the least expensive option is almost always selected

Cost of Incremental Financing for Deployment of CCS Technologies

Literature reviews indicate that while the availability of financing is noted as a barrier, rarely is incremental capital cost of advanced technology singled out as an issue

Acceleration Strategies

- **Demonstration Plants**
- **Public Private Partnerships**
- **Tax Incentives**

IEA-GHG Weyburn CO₂ Monitoring and Storage Project

- Commercial-scale project to utilize CO₂ for enhanced oil recovery at Canadian oil field
- Phase II involves transport of 95 million cubic feet per day of 95% pure CO₂ from North Dakota coal gasification facility through 320-kilometer pipeline to oil field in southern Saskatchewan
- CO₂ will then be injected into the field for enhanced oil recovery
- CSLF-Endorsed



FutureGen Project

- Initiative to build the world's first integrated sequestration and hydrogen production research power plant
- \$1 billion project with goal of zero emissions
- When operational, will be cleanest fossil fuel burning plant in world
- Will utilize coal gasification technology integrated with combined cycle electricity generation and sequestration of carbon dioxide emissions



U.S. Department of Energy Carbon Sequestration Regional Partnerships

- **West Coast Regional Carbon Sequestration Partnership** led by the California Energy Commission, Sacramento, CA, and made up of representative organizations from Alaska, Arizona, California, Nevada, Oregon, Washington and the Canadian Province of British Columbia;
- **Southwest Regional Partnership for Carbon Sequestration** which will involve the efforts of 21 partners in eight states coordinated by the Western Governors' Association and New Mexico Institute of Mining and Technology, Socorro, NM;
- **Big Sky Regional Carbon Sequestration Partnership** which will be headed by Montana State University, Bozeman, MT, and cover Idaho, Montana, and South Dakota;
- **Plains CO2 Reduction Partnership** which will extend across Minnesota, North Dakota, South Dakota, Nebraska, Iowa, Missouri, Wisconsin, Montana, Wyoming and three Canadian provinces. It will be led by the Energy & Environmental Research Center at the University of North Dakota, Grand Forks, ND;



Carbon Sequestration Regional Partnerships (cont'd)

- **Midwest (Illinois Basin) Geologic Sequestration Consortium** will evaluate sequestration options in the Illinois Basin of Illinois, western Indiana, and western Kentucky. It will be led by the University of Illinois, Illinois State Geological Survey;
- **Southeast Regional Carbon Sequestration Partnership**, headed by Southern States Energy Board, Norcross, GA, and involving Arkansas, Louisiana, Mississippi, Alabama, Tennessee, Georgia, Florida, North Carolina, Virginia, Texas, and South Carolina;
- **Midwest Regional Carbon Sequestration Partnership** covering Indiana, Michigan, Maryland, Kentucky, Ohio, Pennsylvania, and West Virginia and coordinated by the Battelle Memorial Institute, Columbus, OH.



Surge in U.S. Applications for Clean Coal Tax Credits

- Tax credit programs created by Energy Policy Act of 2005 lead to 49 tax credit applications submitted to USDOE for construction of clean coal and gasification projects
- 22 filed under the coal-based program in 19 states for integrated gasification combined cycle

Three Corporate Strategies



Texas Utilities (TXU)

Coal-Fired Power Plant Expansion

- TXU to expand output by 9,000 megawatts over 4 years by building new pulverized coal power plants in Texas, which is not moving to restrict CO₂ emissions
- “This project will use the Best Available Control Technology to reduce air emissions.” (TXU web site)
- Even in U.S., cost constraints in highly competitive generation markets may cause CCS to be utilized in only a small percentage of new power projects

Xcel Energy

Clean Coal Investment

- \$3.5 million through 2007 to study development of clean coal plant in Colorado utilizing coal gasification
- Potential to reduce emissions 25 – 90 %
- Vital because 25 new coal plants proposed throughout U.S. Midwest

NRG

Power Plant Construction

- NRG to increase generating capacity 40% over next decade at cost of ~\$16 billion
- Nuclear, coal, wind turbine and natural gas plants planned for total of 10,500 megawatts
- CEO David Crane states the power industry has “moral imperative” to reduce CO₂ output
- IGCC plants planned for Delaware and New York or Connecticut
- Enormous increase in generating capacity, yet net decrease in CO₂ emissions

Thank you.

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