Reducing CO_2 Emissions From Fossil Fuel Power Plants

EPGA's 3rd Annual Power Generation Conference

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Hershey, Pennsylvania

Scott M. Klara - National Energy Technology Laboratory

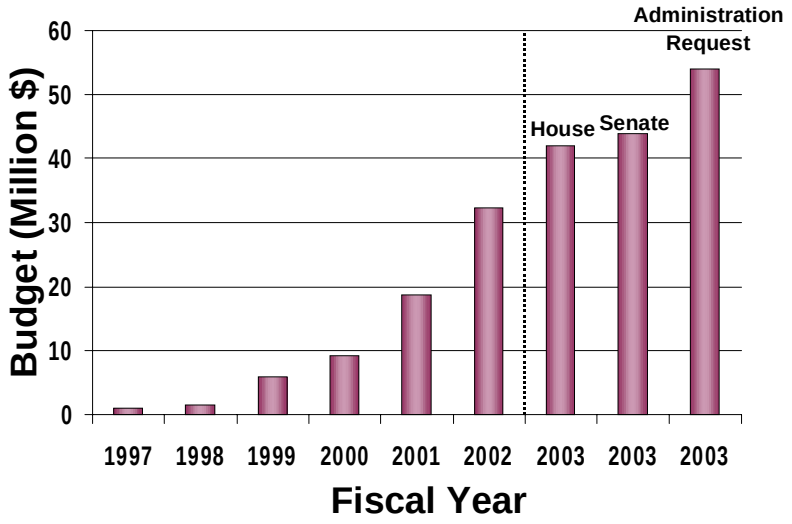
National Energy Technology Laboratory

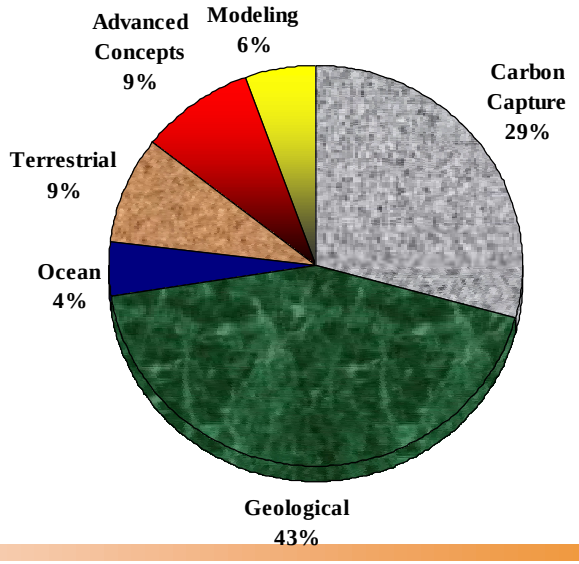
- One of DOE's 17 national labs
- Government owned/operated
- Sites in Pennsylvania, West Virginia, Oklahoma, Alaska
- More than 1,100 federal and support contractor employees
- FY 02 budget of $750 million

Carbon Sequestration: A Dynamic Program

Separation & Capture From Power Plants Plays Key Role

- **Diverse research portfolio**
  - 60 external projects
  - Onsite focus area
- **Strong industry support**
  - 40% cost share
- **Portfolio funding $100M**





Technology R&D Pathways

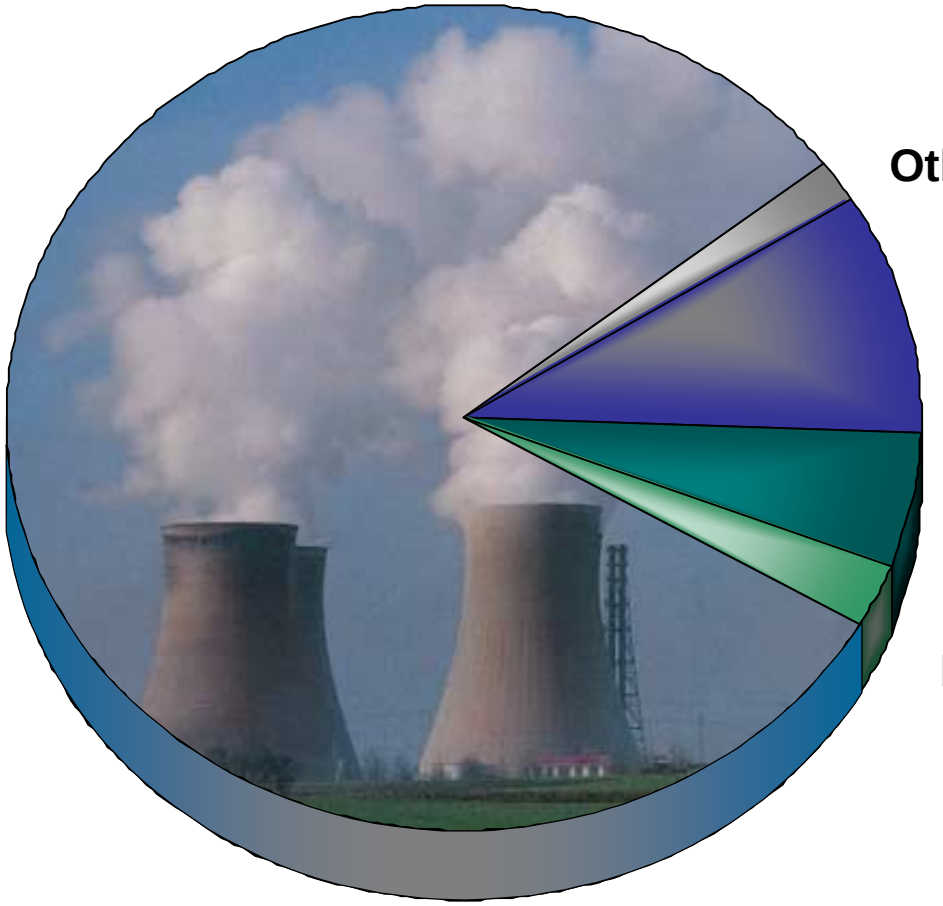
• Separation and Capture	• Pre-combustion Decarbonization • Oxygen-Fired Combustion • Post-combustion Capture • Advanced Integrated Capture Systems • Crosscutting Science and Technology
• Geologic Sequestration	• Monitoring, Verification, and Remediation Technology • Health, Safety, and Environmental Risk Assessment • Knowledge Base and Technology for Storage Reservoirs
• Terrestrial Sequestration	• Productivity Enhancement • Ecosystem Dynamics • Monitoring and Verification
• Ocean Sequestration	• Ecosystem Dynamics • Measurement and Prediction • Direct Injection of CO_2 • Ocean Fertilization
• Novel Sequestration Systems	• Biogeochemical Processes • Mineral Conversion • Novel Integrated Systems • Crosscutting Science and Technology

Where Is The Problem?

CO_2 & CH_4 - The Primary GHG Contributors

United States Greenhouse Gas Emissions

(Equivalent Global Warming Basis)



CO_2 from Energy 81%

Other CO_2 3%

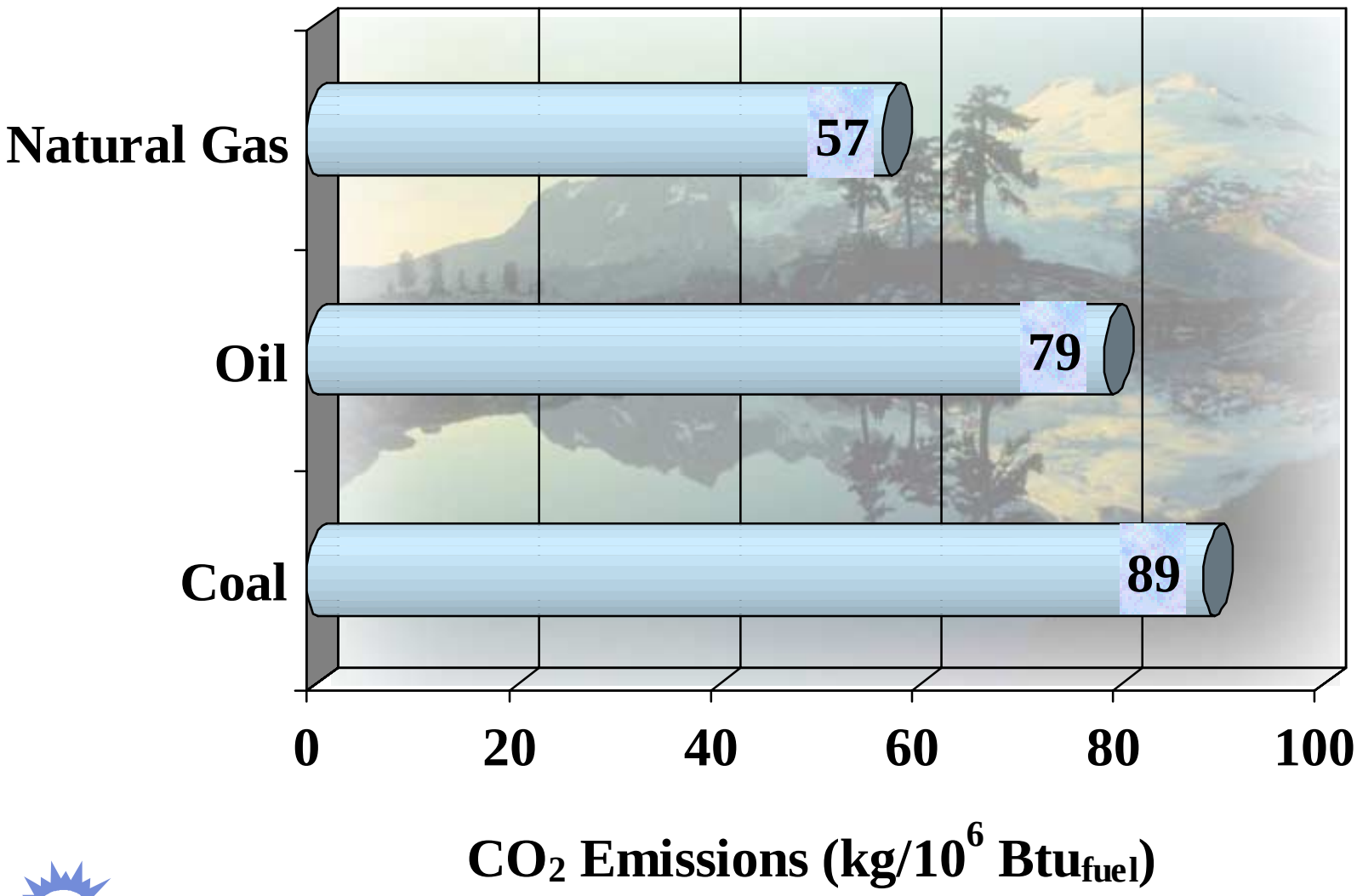
Methane 9%

Nitrous Oxide 5%

HFCs, PFCs, SF_6 2%

"EIA Emissions of Greenhouse Gases in the U.S.: 2000"

Fossil Fuel's Inherent CO_2 Disadvantage



Source: NETL Combustion Calculations - HHV Basis

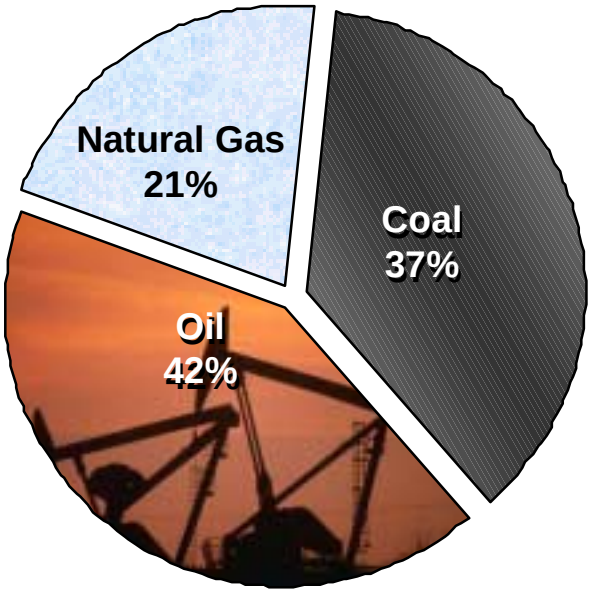
Coal & Electricity Are Major CO_2 Contributors

1998 United States CO2 Emissions

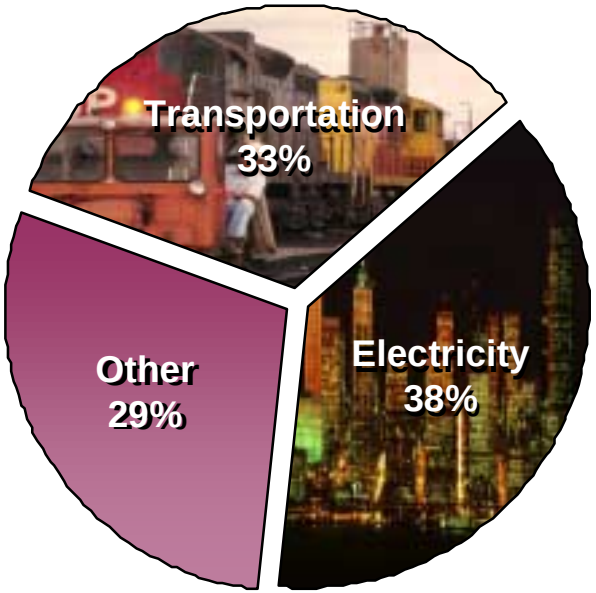
(Million Metric Tons Per Year Carbon Equivalent)

(Total Emissions = 1450)

By Fossil Fuel Type

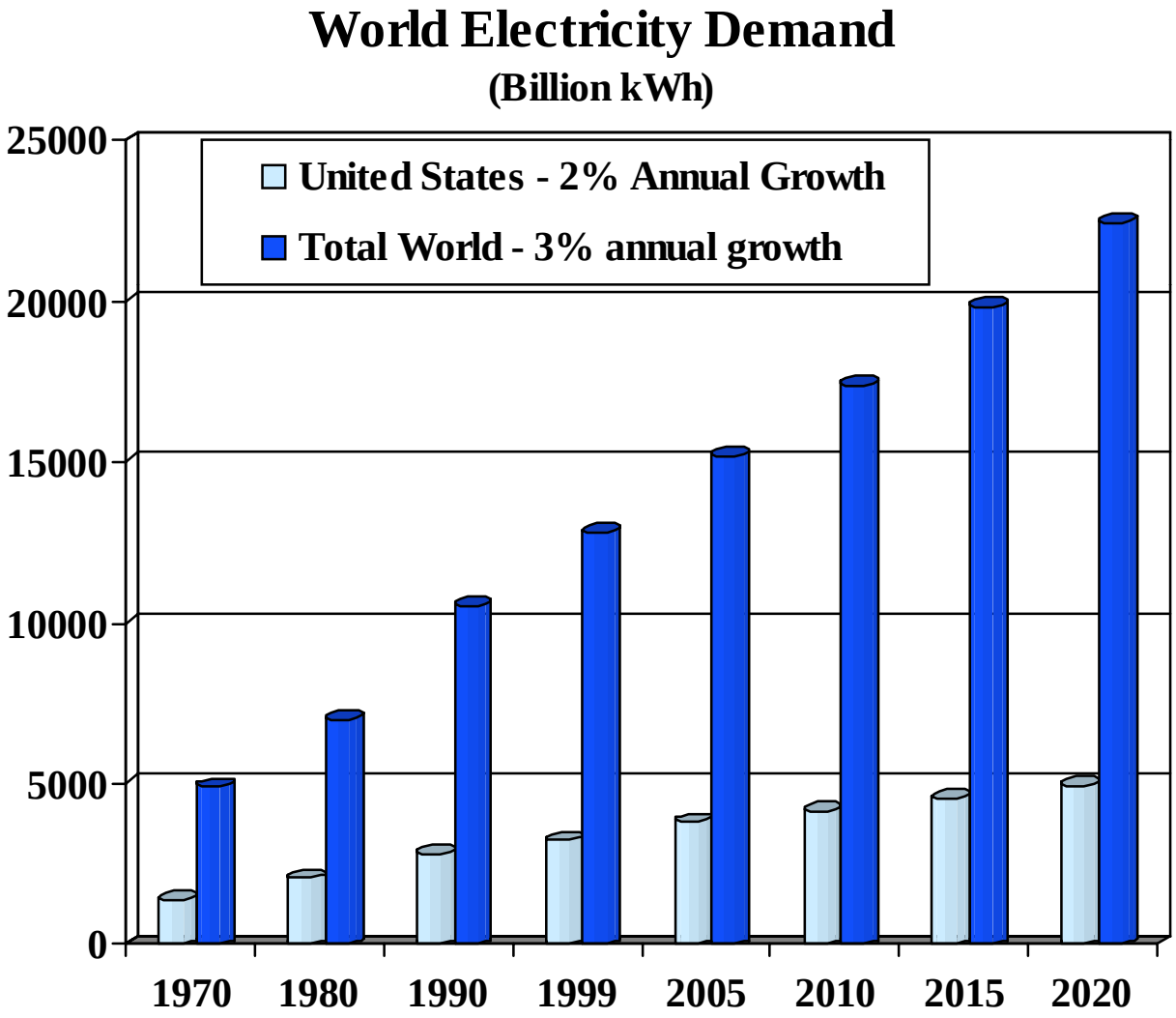


By Sector



Source: EPA, Inventory of Greenhouse Gas Emissions, 2000

Greenhouse Gas Emission Will Grow



Source: EIA International Energy Outlook 2002

Technological Carbon Management Options

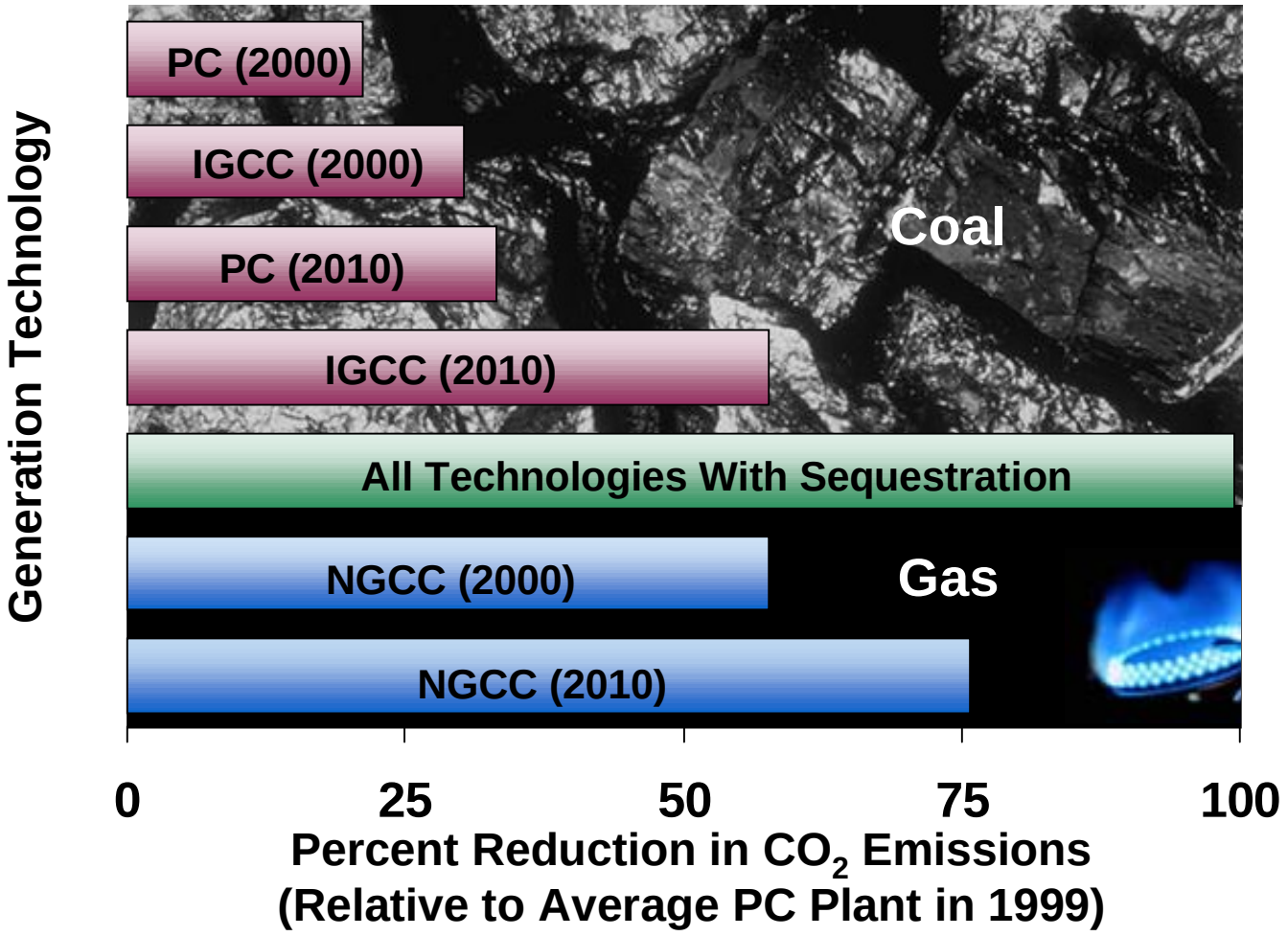
Reduce Carbon Intensity	Improve Efficiency	Sequester Carbon
• Renewables • Nuclear • Fuel Switching	• Demand Side • Supply Side	• Capture & Store • Enhance Natural Sinks

All options needed to:

- **Affordably meet energy demand**
- **Address environmental objectives**

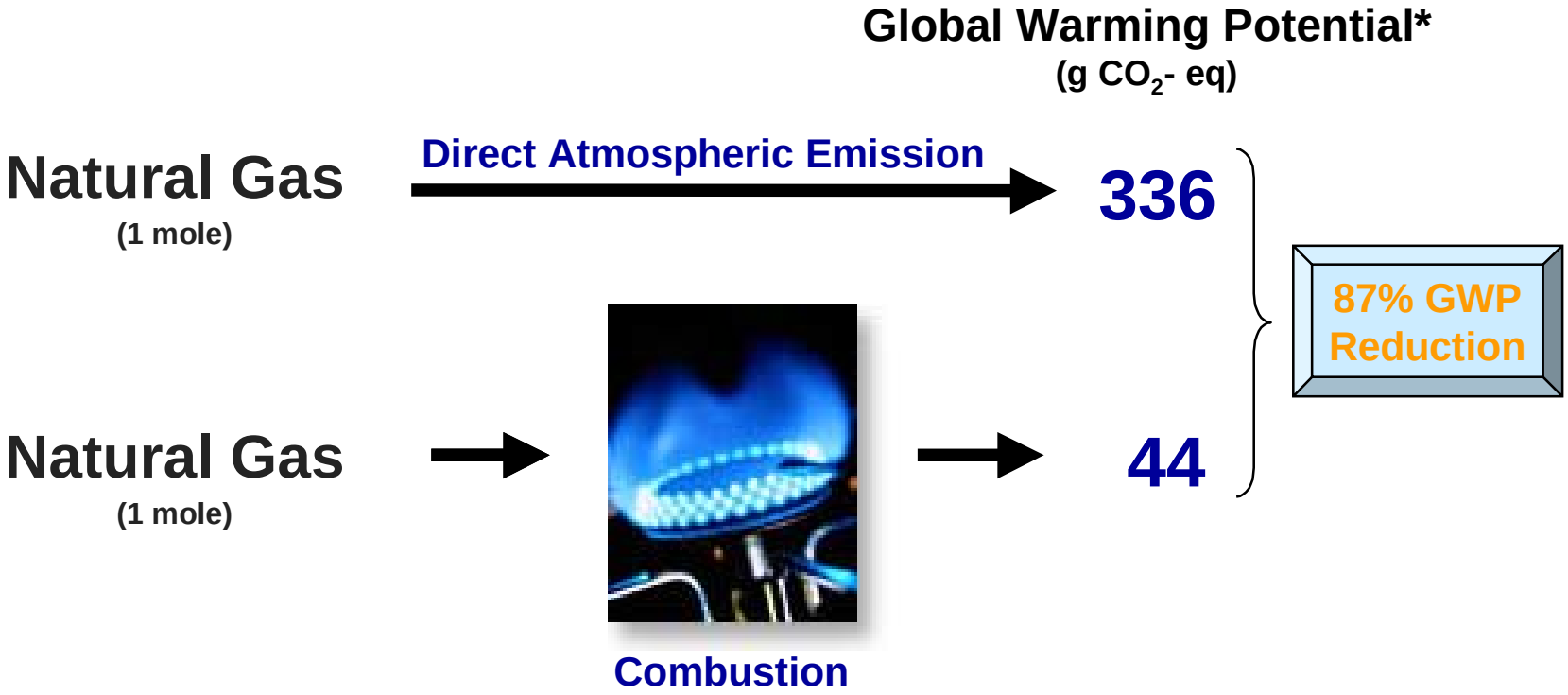
Increased Efficiency Reduces CO_2 Emissions

> 25% Reduction With Current & Future Technology



Can Methane Combustion Reduce GWP?

87% Reduction in Global Warming Potential Versus Fugitive Release



*100-Year Time Horizon GWP for Methane = 21 g CO_2/g CH_4

Source: Energy Information Administration

Separation and Capture Highlights

Many Advanced Integrated Schemes Emerging

Coal Gasification

CO_2 Hydrates
Membranes
Advanced Scrubbers Cheap Oxygen

Pathways to Zero Emissions

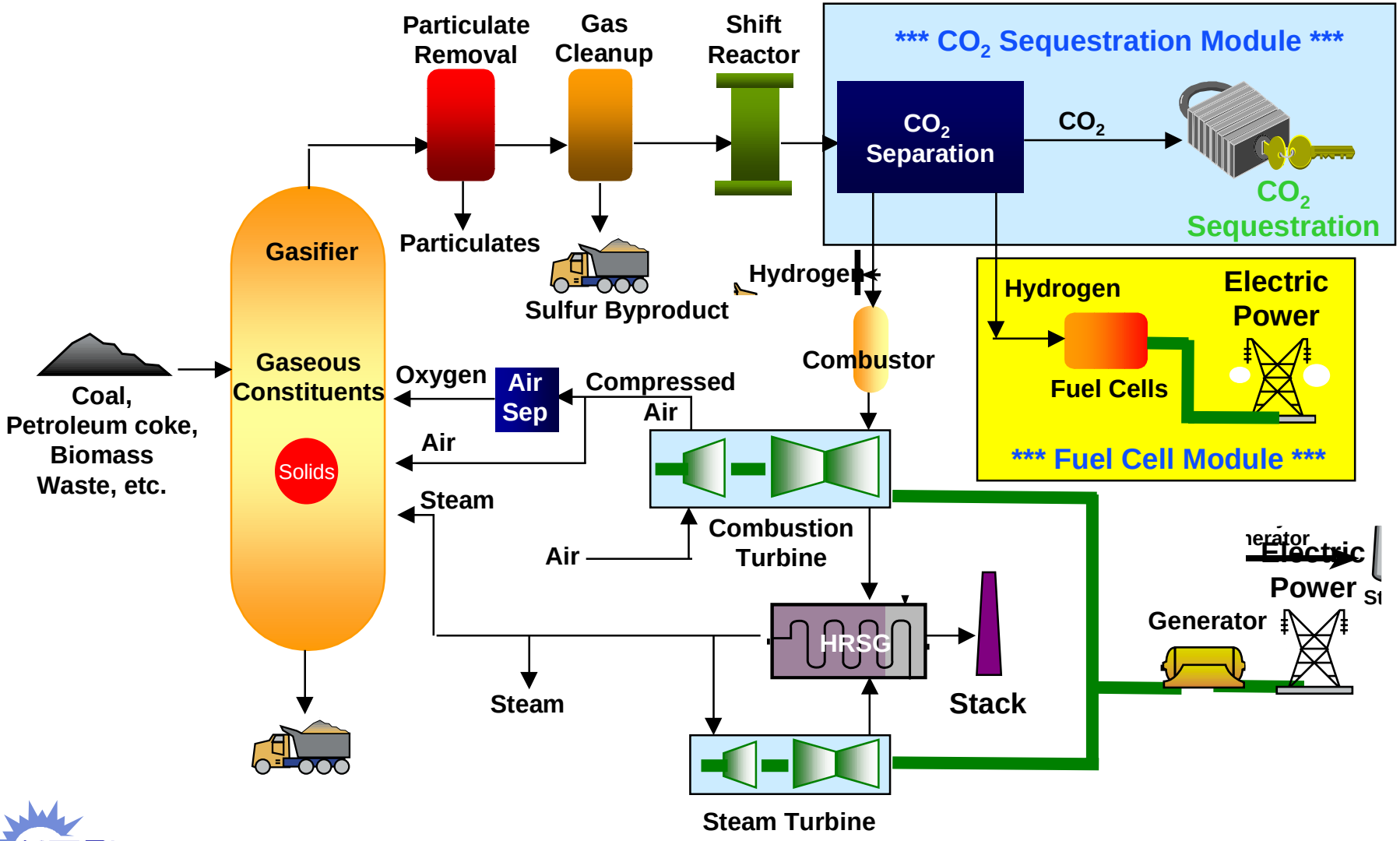
Pulverized Coal

Membranes
Advanced Scrubbers
New Sorbents
Mineral Carbonation

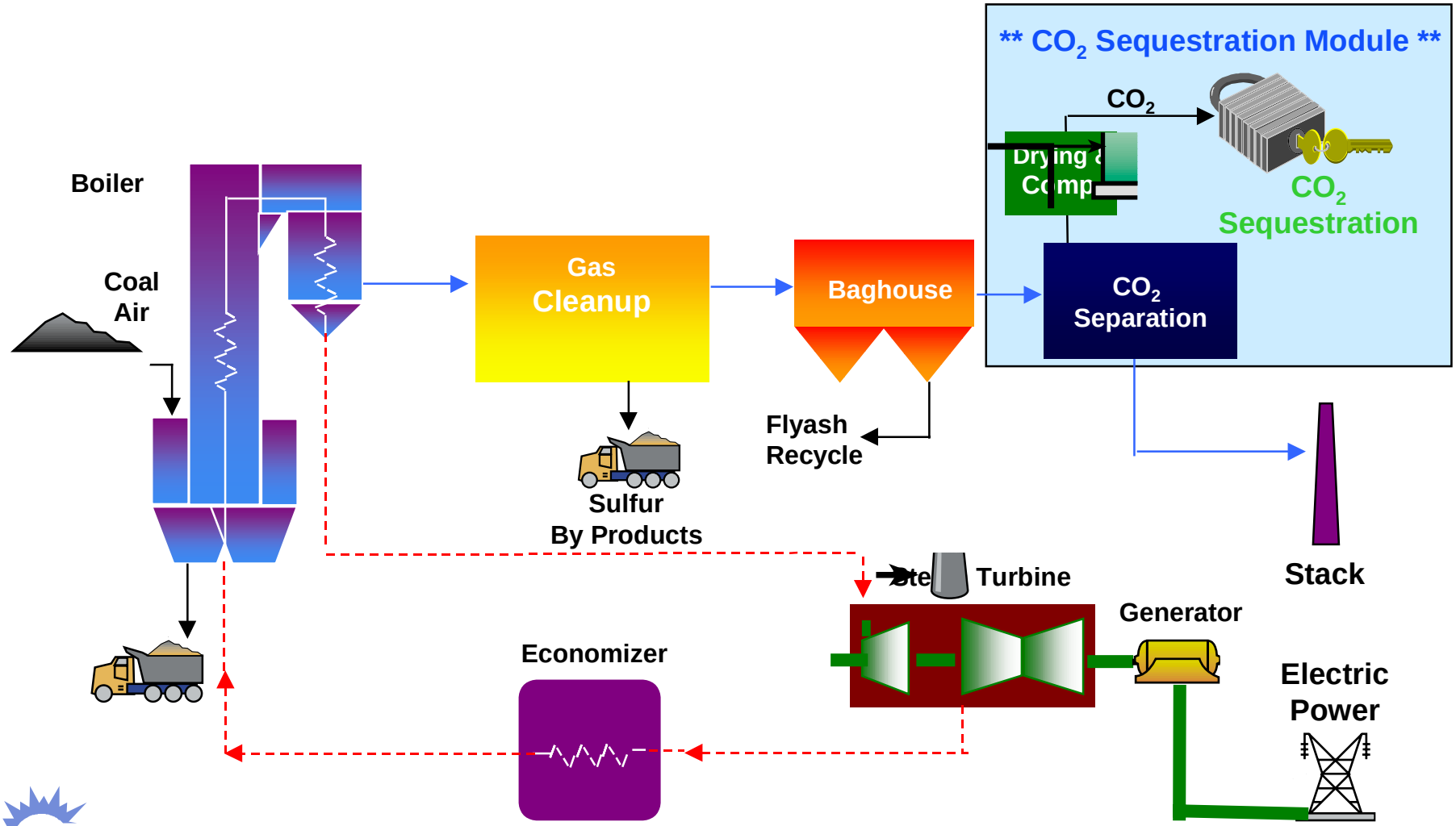
Producing a Concentrated Stream of CO_2 at High Pressure

- ***Improves Sequestration Economics***
- ***Reduces Energy Penalty***

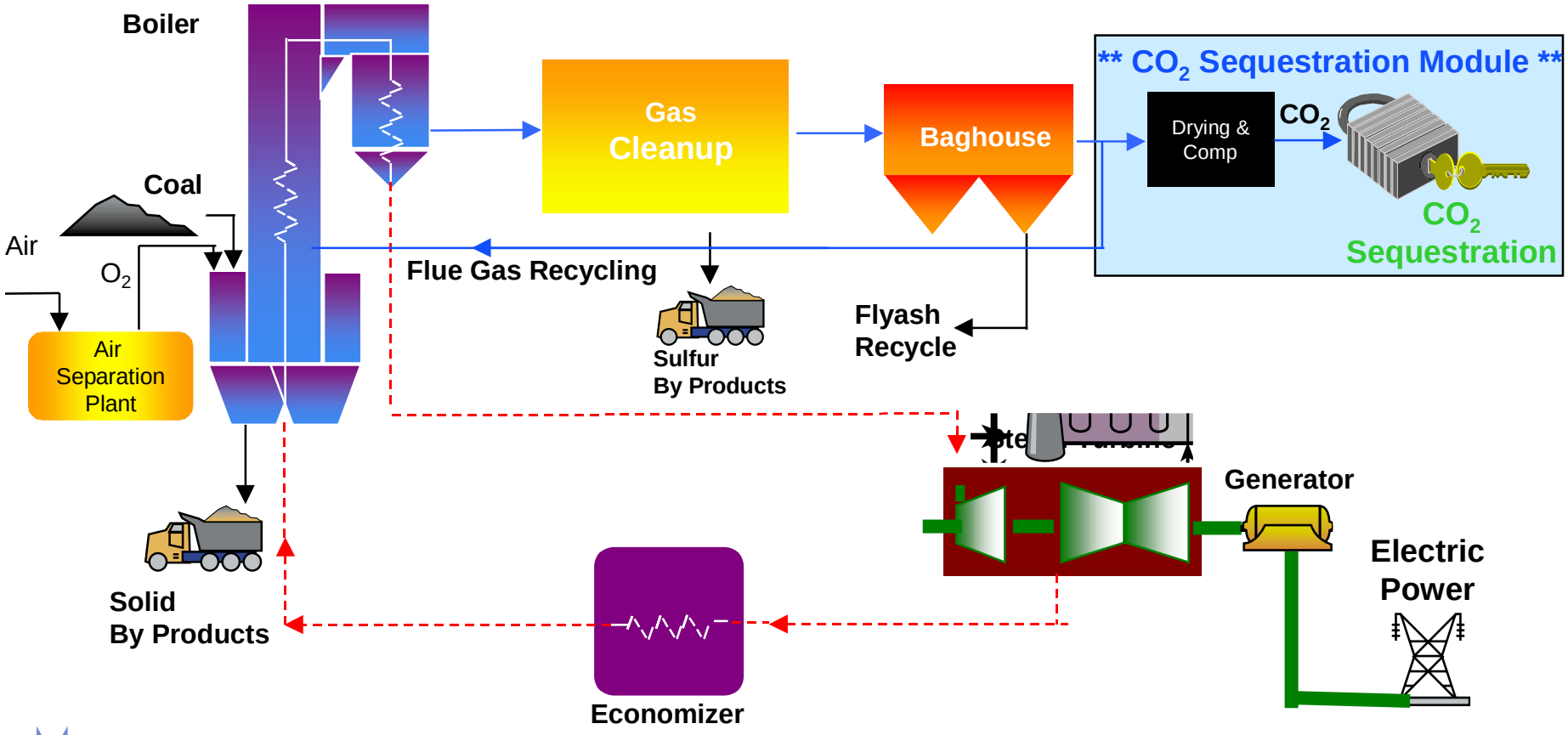
CO_2 Sequestered Gasification Plant
(Scrubbing, Membranes, Lower Cost O_2, Hydrates)



CO_2 Sequestered PC Plant
(Scrubbing, Membranes)

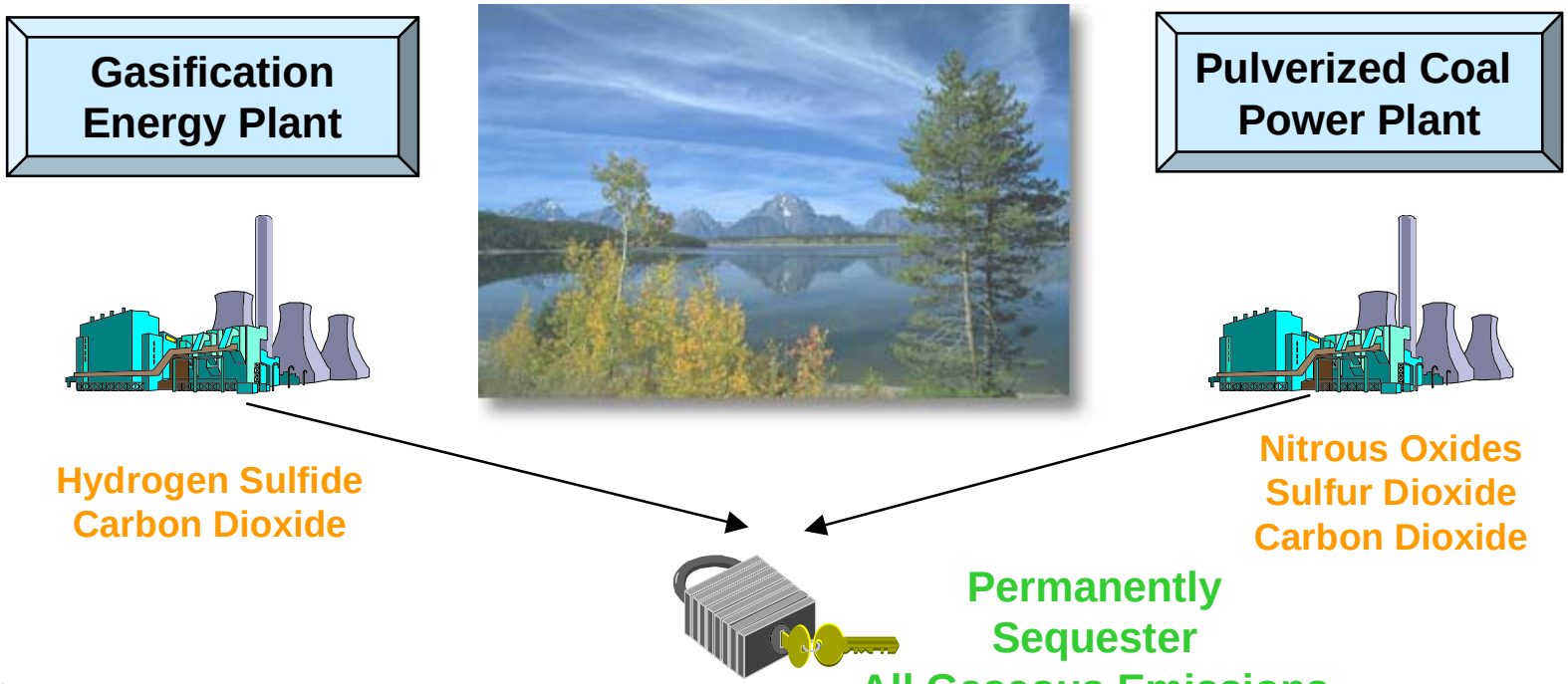


CO_2 Sequestered PC Plant
(O_2 Combustion, Lower Cost O_2)



Sequestration - Not Just About CO_2
(Near Zero Emissions Concept)

- Sequester traditional pollutants & CO_2
- Avoid costs, energy & complexity of controlling traditional pollutants
- Provide major cost & energy offsets for CO_2 capture & sequestration
- Substantially reduce footprint and complexity of plants

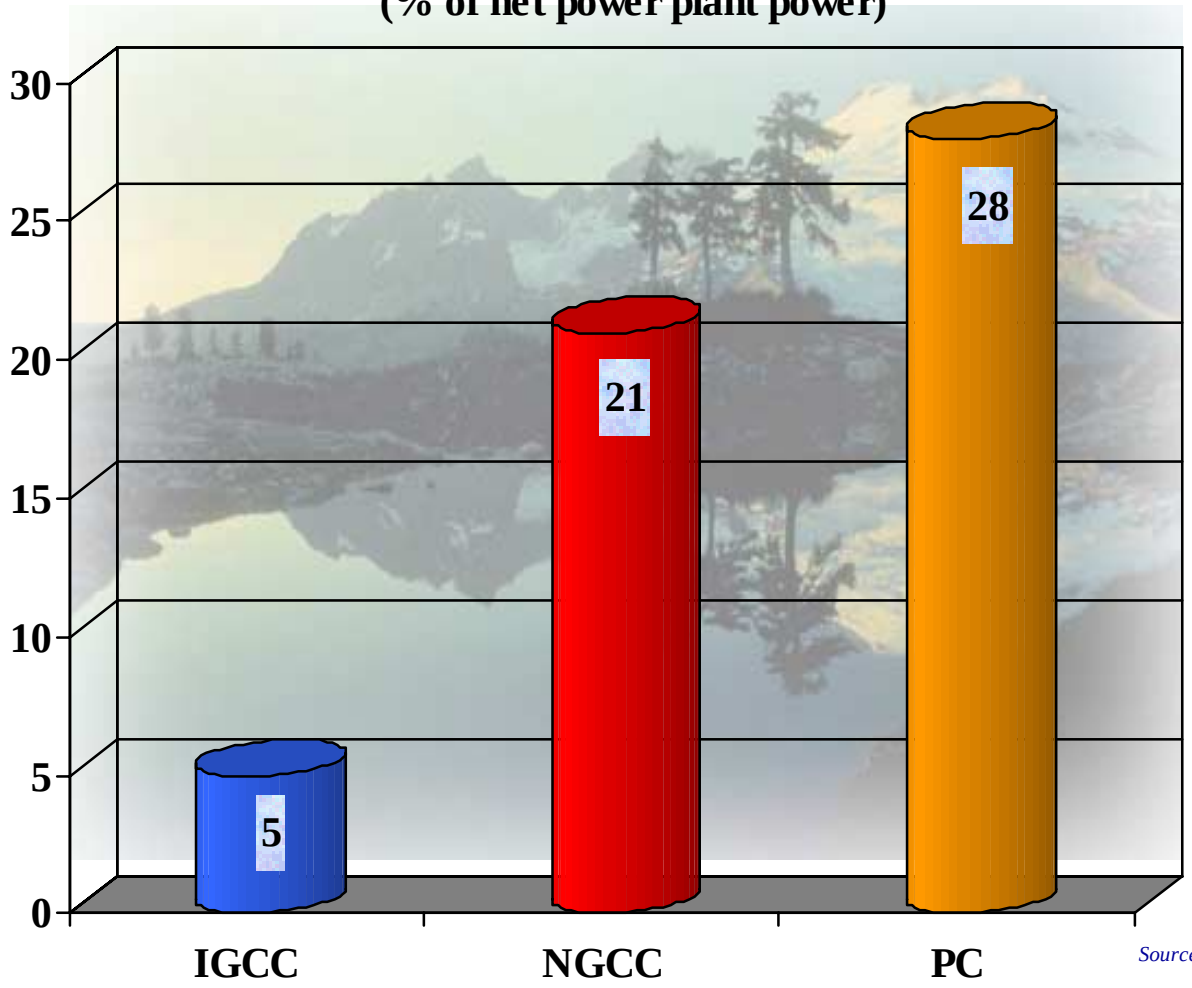


Substantial Energy Penalty of CO_2 Capture

With State-of-Art Scrubbing Technologies

Parasitic Power Loss for CO_2 Capture

(% of net power plant power)



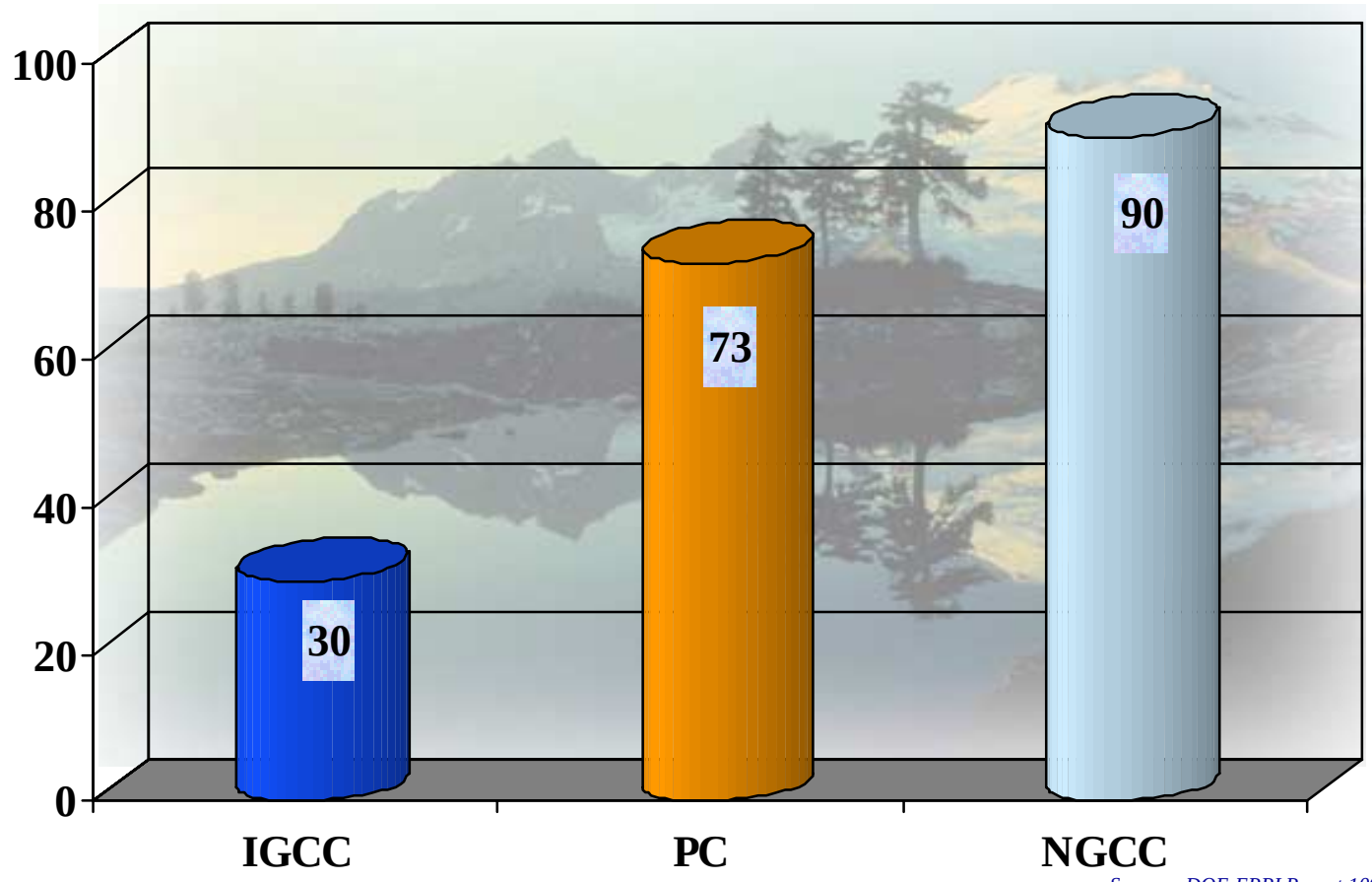
Source: DOE-EPRI Report 1000316, 12/2000

Substantial Capital Cost Impact of CO_2 Capture

With State-of-Art Scrubbing Technologies

Effect of CO_2 Capture on Capital Cost

(% Increase Resulting From CO_2 Capture)



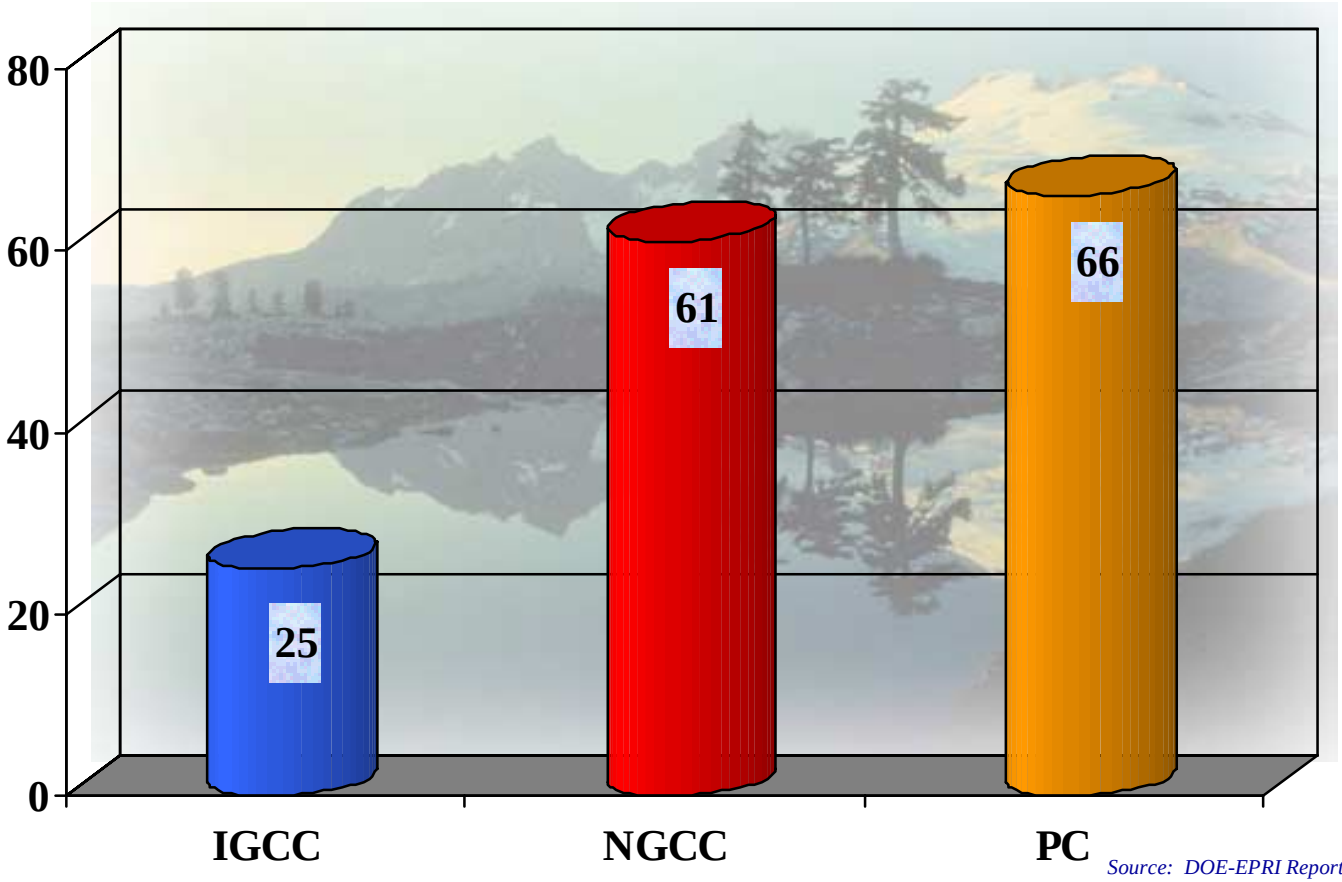
Source: DOE-EPRI Report 1000316, 12/2000

Substantial COE Impact of CO_2 Capture

With State-of-Art Scrubbing Technologies

Effect of CO_2 Capture on Cost of Electricity

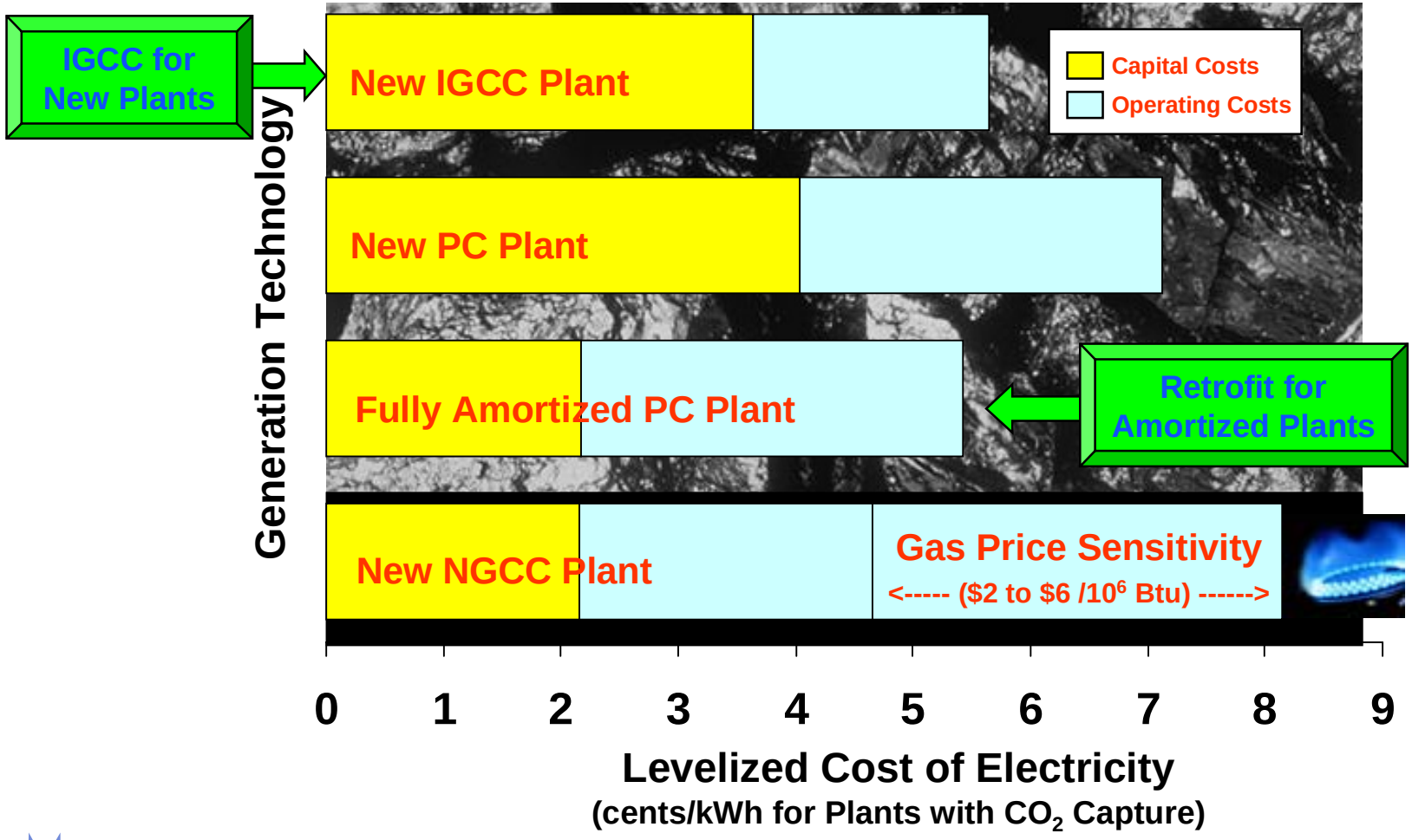
(% Increase Resulting From CO_2 Capture)



Source: DOE-EPRI Report 1000316, 12/2000

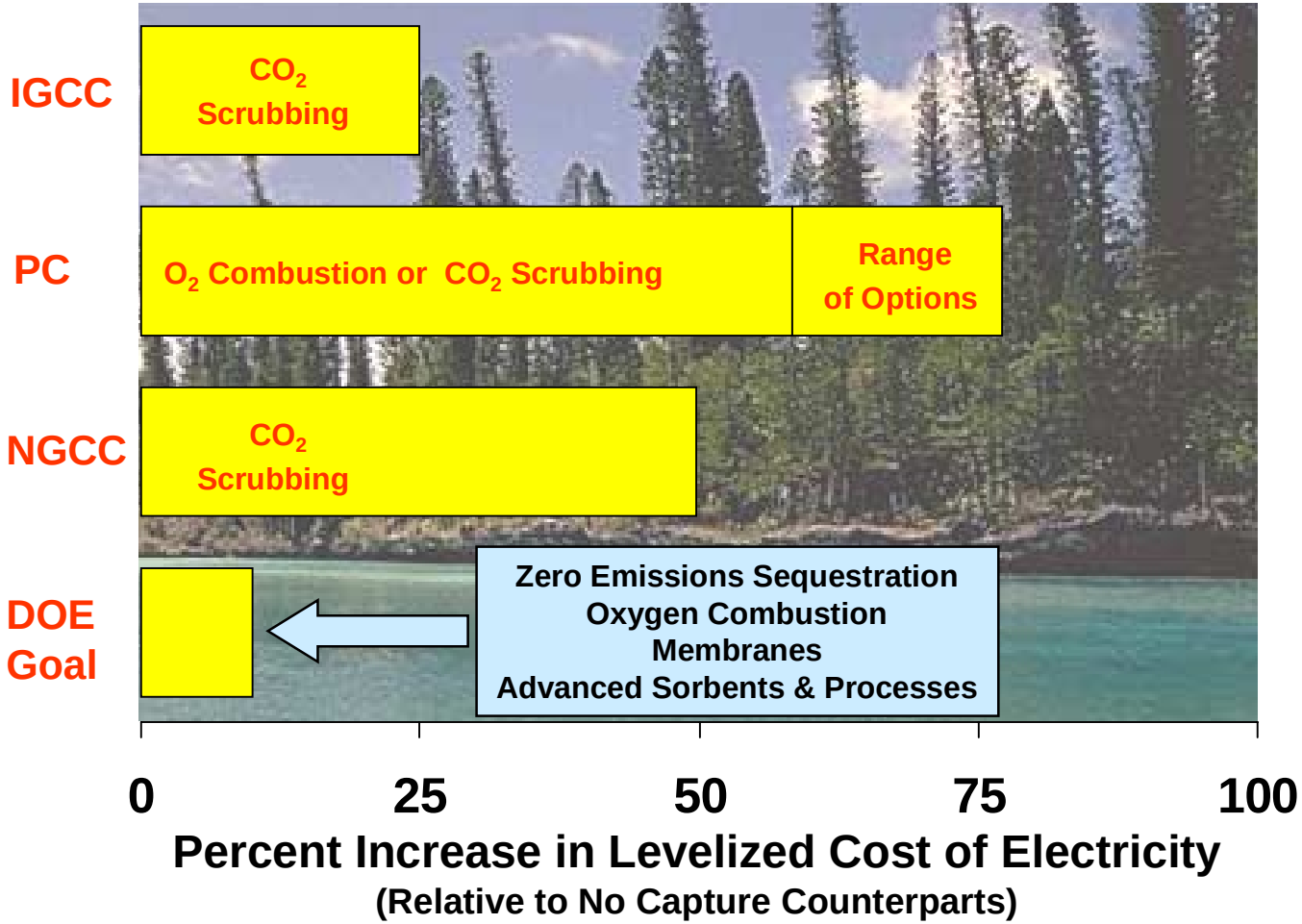
What About Existing Coal Fleet?

Existing Fleet Can Compete!



Sources: Derived From NETL, EPRI, Alstrom

A Challenging Road Ahead !!!!



Sources: Derived From NETL, EPRI, Alstom

Visit Our NETL Sequestration Website

www.netl.doe.gov/coalpower/sequestration/