Status and Progress of IGCC and Co-Production Technology in the United States

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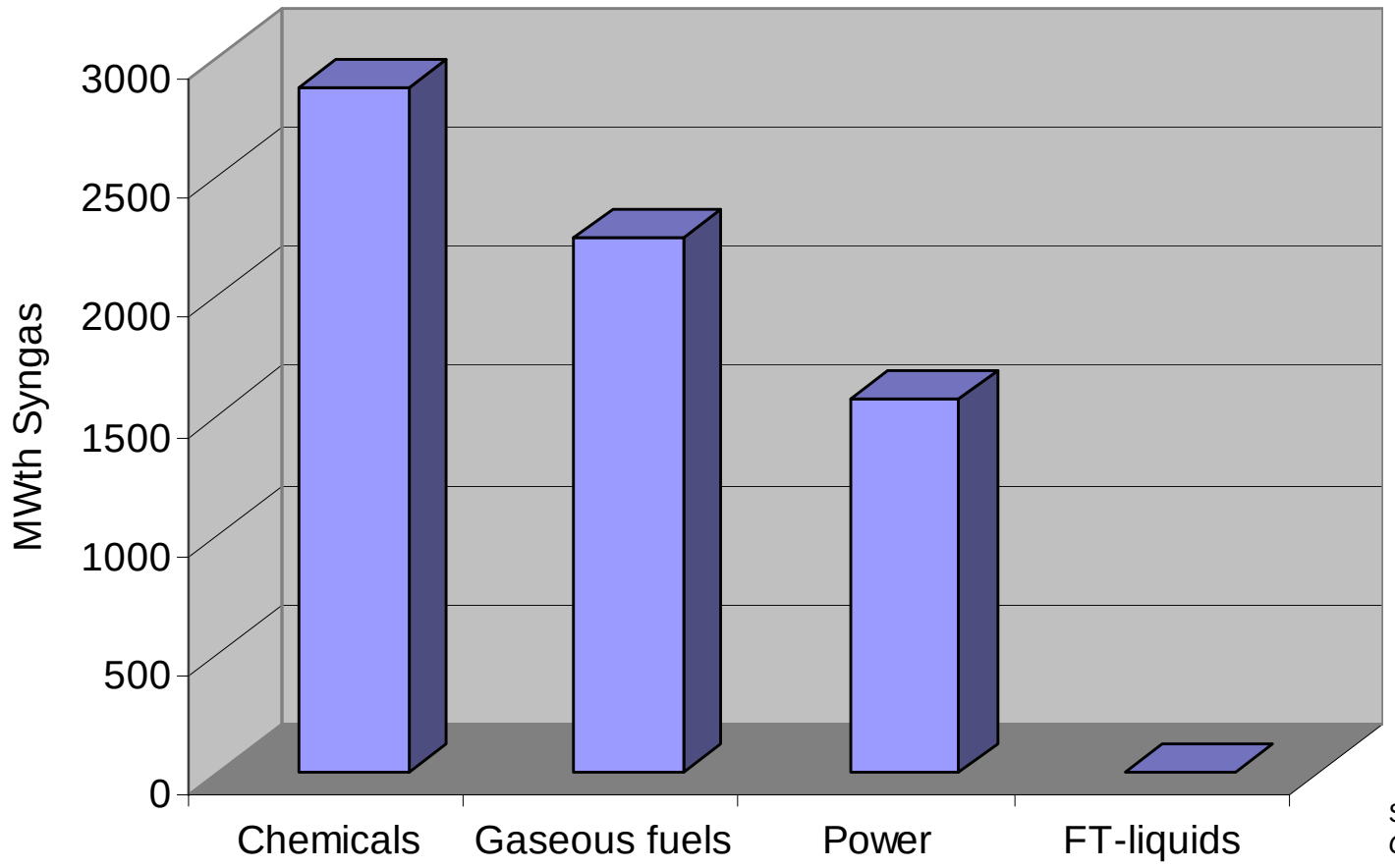
Outline

- Gasification projects in the U.S.
- Growth of IGCC projects in U.S.
- FutureGen
- Coal-to-liquids
- Policy incentives for IGCC & CTL under existing U.S. law
- Future U.S. climate policy and incentives for IGCC/CTL/CCS technology deployment

Gasification in the U.S.

- Gasification is a well-tested and commercial technology for chemicals production
- Gasification for power (IGCC) has been tested at commercial scale
  - Not yet deployed at a large scale
- Increasing interest in IGCC for controlling CO_2 emissions
- Energy security concerns and high price of oil is increasing interest in CTL
- Diverse set of technology providers and new industrial alliances helping commercialization
  - GE Energy/Bechtel; ConocoPhillips/Fluor/Siemens; Shell/Uhde/Black & Veatch

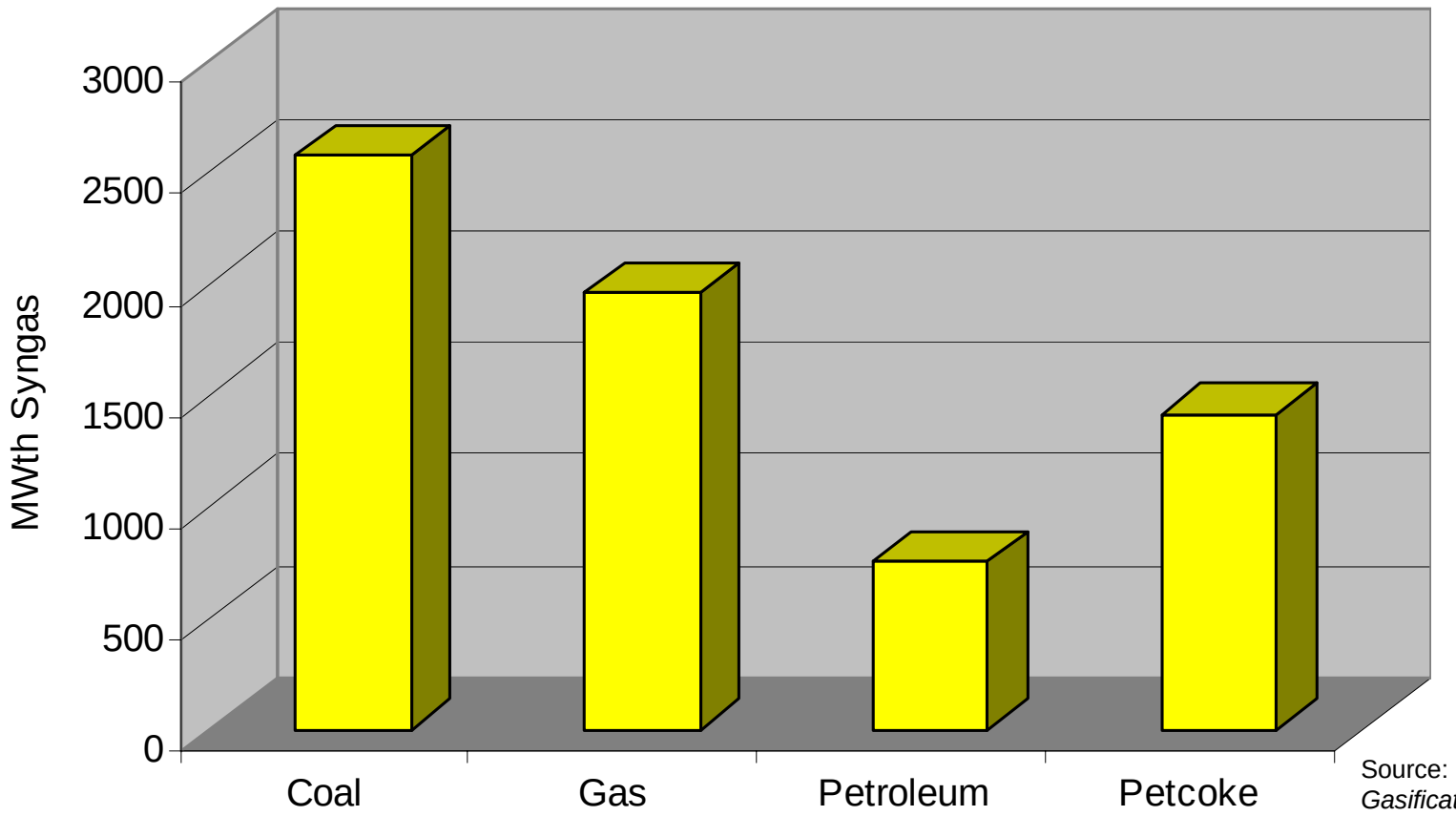
Operating U.S. gasifiers by product



Source: *U.S. DOE Gasification Database 2004*

- No FT-liquids plants in operation today in U.S.
- Mostly dominated by chemicals and gaseous fuels
- Power from IGCC demonstration plants (DOE supported)

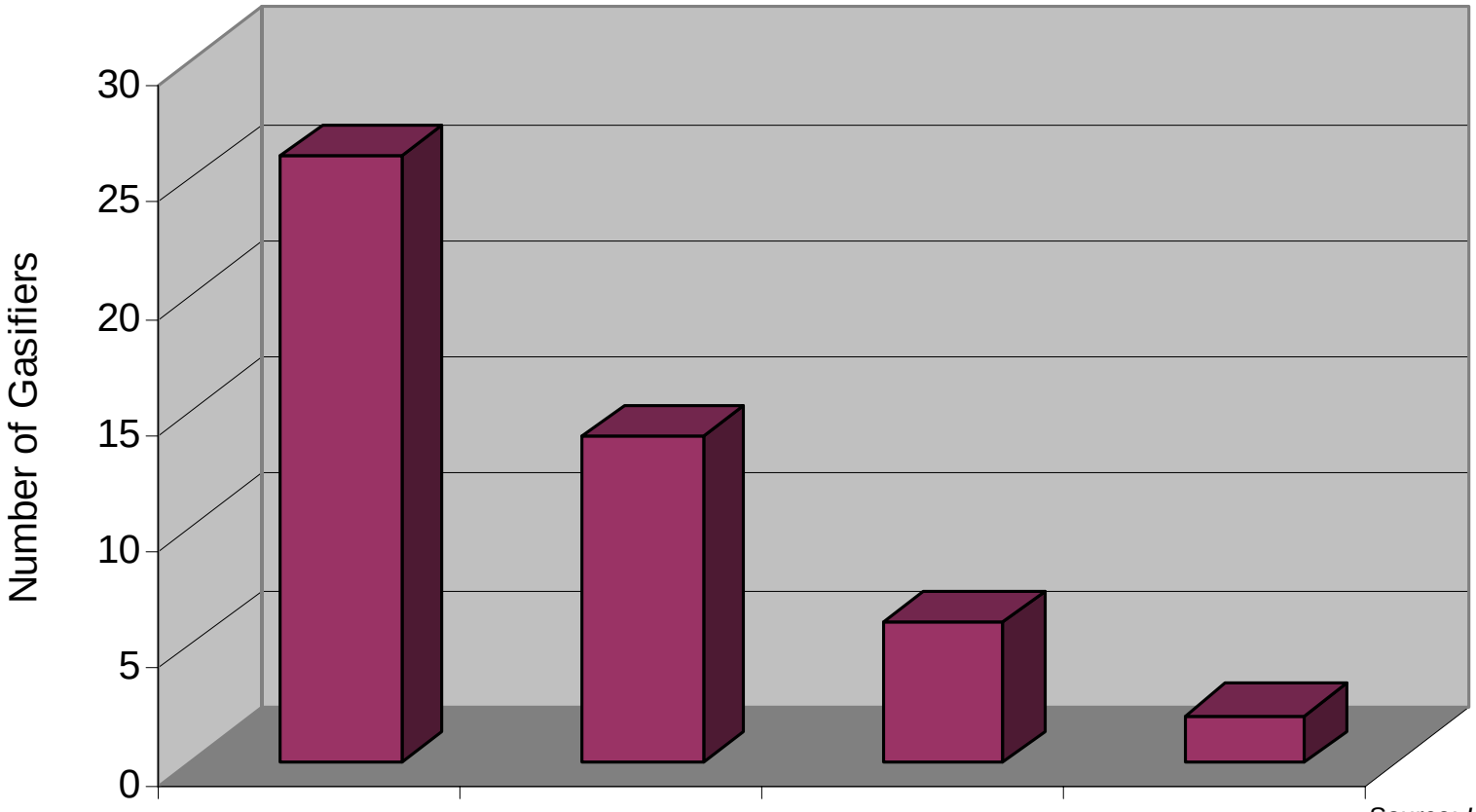
Operating U.S. gasifiers by feedstock



Source: *U.S. DOE Gasification Database 2004*

- Coal dominates current gasifier feedstocks
- Gas is also dominant, but high prices may limit its future use
- Petcoke is an important feedstock

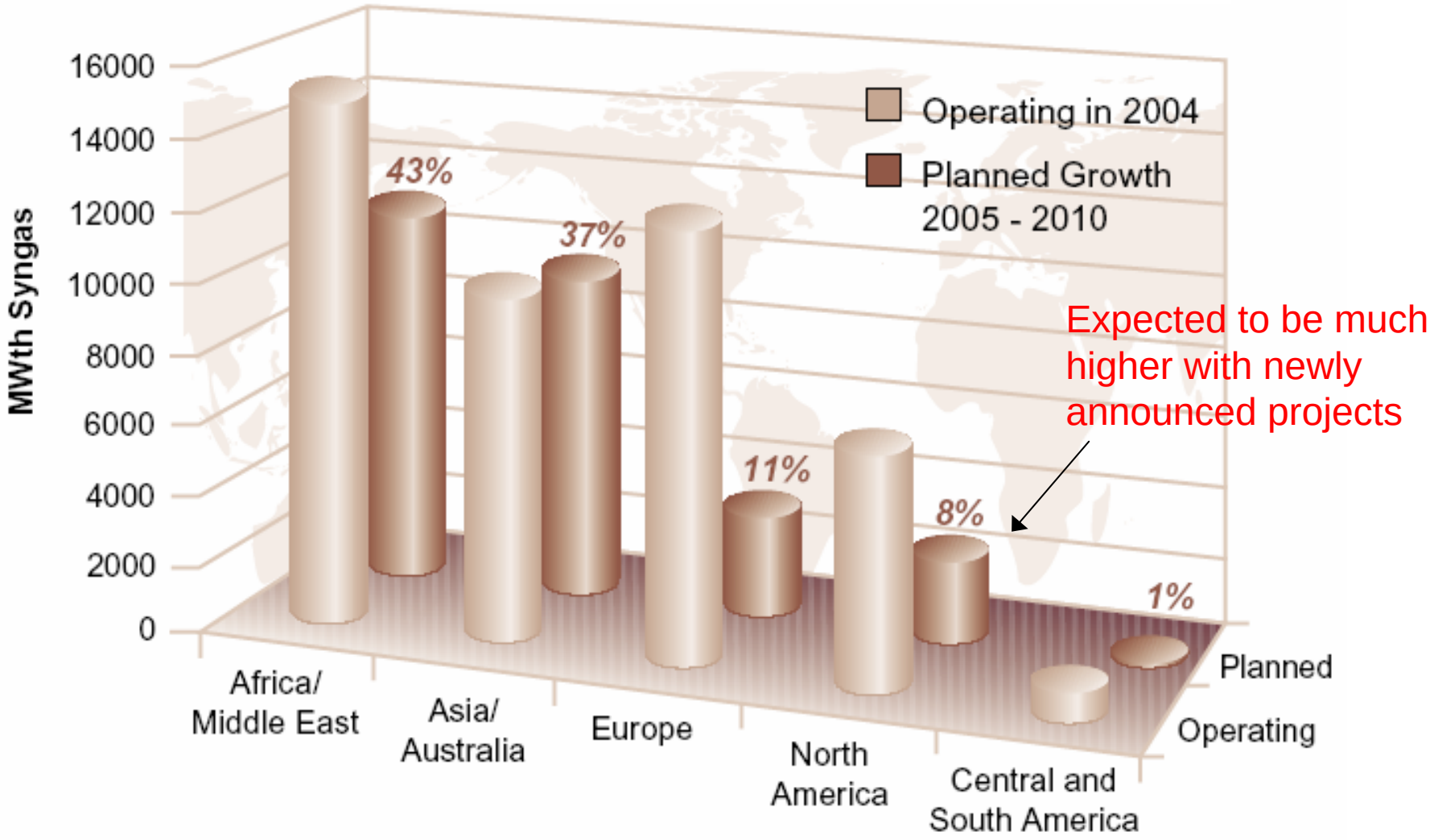
Operating U.S. gasifiers by type



Source: *U.S. DOE Gasification Database 2004*

- GE dominates current gasifier portfolio
- Opportunities for other manufacturers as well

World Gasification by region



U.S. DOE 2005

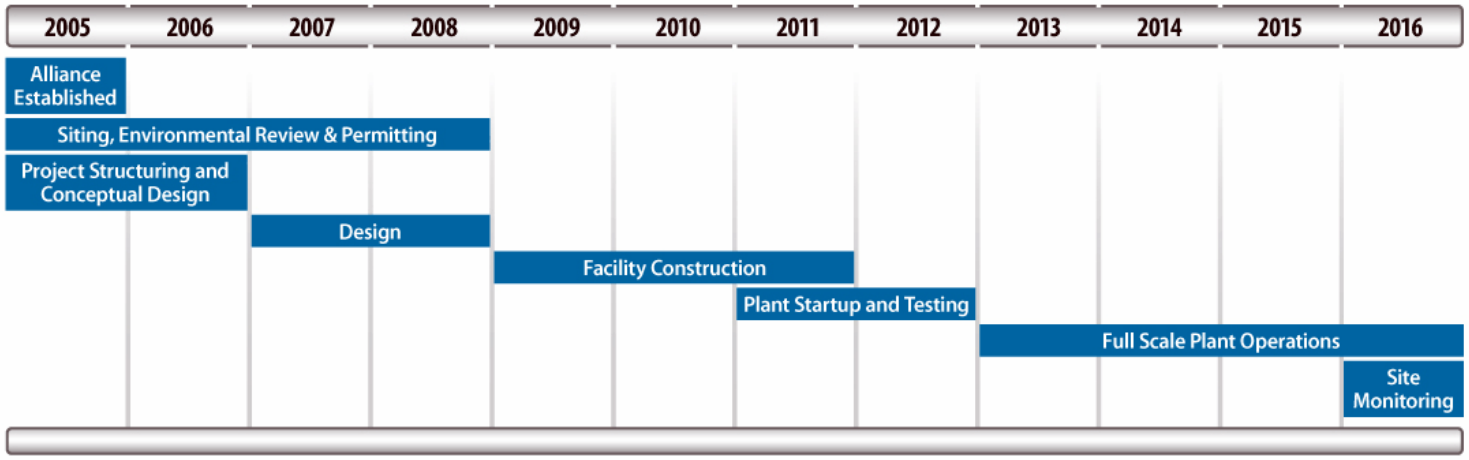
Share of Planned Growth in World Gasification Capacity Shown in Percent

Selected commercial IGCC projects

- AEP – one or more 600 MW commercial plants
  - Working with GE-Bechtel Alliance
  - Three proposed sites (Ohio, W. Virginia, Kentucky)
- Southern Illinois Clean Energy Center – 630 MW
- Taylorville Energy Center – 660 MW
- Duke Energy – 600 MW
- Mesaba -- 600 MW IGCC
- Rentech Royster Clark – 600 MW
- BP-Edison Mission, petcoke-based 500 MW IGCC and CCS with EOR
- Orlando Gasification – 285 MW KBR Transport gasifier

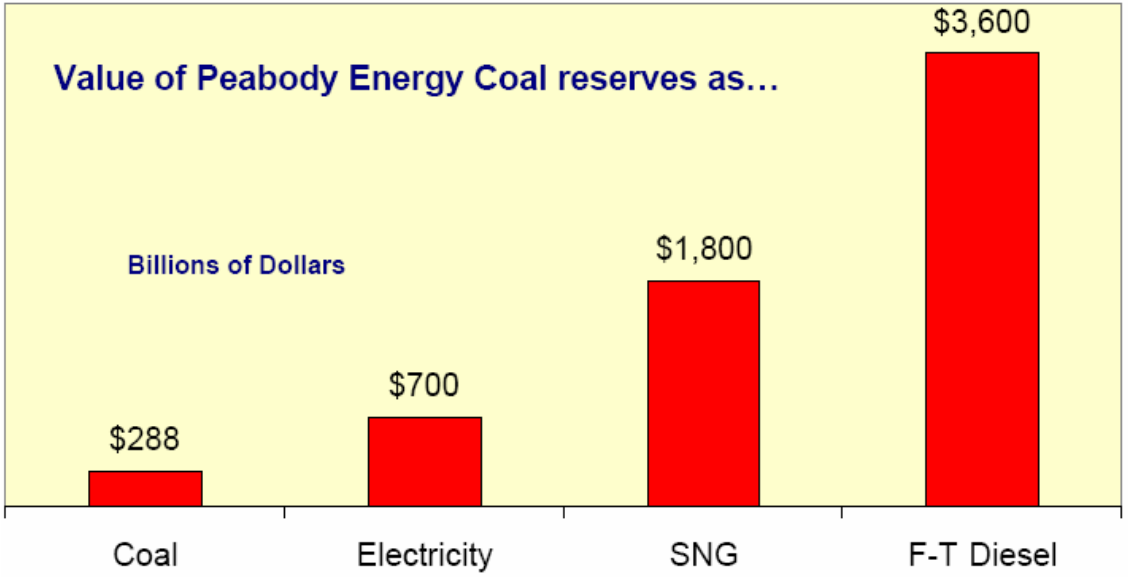
FutureGen

- $1.5 billion integrated hydrogen production and carbon storage research plant – DOE investing $1.1 billion
- FutureGen Industrial Alliance ($400 million)
  - AEP, Peabody Energy, Southern Company, Rio Tinto Energy, Huaneng Group, etc.
- Four possible sites selected
  - Mattoon, IL, Tuscola, IL, Jewett, TX, Odessa, TX
- Draft environmental impact statement and public hearings
- International participation (steering committee and alliance)



U.S. DOE

Coal-to-Liquids

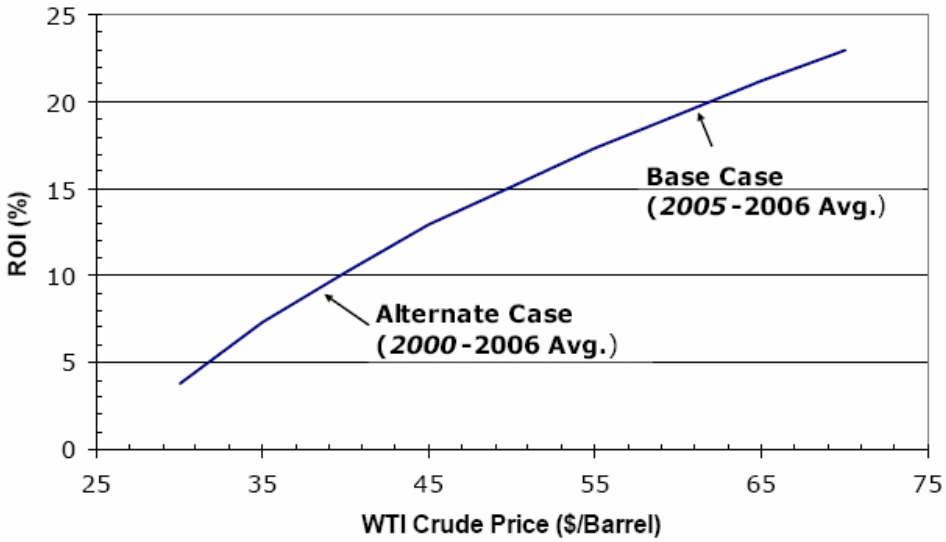


Peabody Energy
(Childress 2007)

High value for FT liquids
Driven by high price of oil

Decisions to build CTL plants depend on production costs and cost of oil

Need for incentives to build CTL plants



DOE/NETL (2007)

Policies and Incentives

Leadership of the independent, bipartisan, US National Commission on Energy Policy (NCEP), 2002-7

JOHN P. HOLDREN
Co-Chair
Teresa and John Heinz Professor of Environmental Policy, Harvard University

WILLIAM K. REILLY
Co-Chair
Founding Partner, Aqua International Partners; former Administrator of the U.S. Environmental Protection Agency

JOHN W. ROWE
Co-Chair
Chairman and CEO, Exelon Corporation

PHILIP R. SHARP
Congressional Chair
Senior Policy Advisor, Van Ness Feldman PC; Senior Advisor, Lexecon, Inc.; former U.S. Representative, IN

NCEP 12-08-2004 recommendations on clean coal

POLICY RECOMMENDATIONS

Advanced Coal Technologies

The Commission believes that support for first-mover sequestration-capable IGCC facilities is appropriate given this technology's potential for simultaneously addressing economic, environmental and energy security concerns. Thus, the Commission recommends that the federal government:

- Provide up to $4 billion over ten years to support the early deployment of roughly 10 GW of sequestration-ready IGCC plants.
- Provide support for the commercial-scale demonstration of geologic carbon storage at a variety of sites with an investment of $3 billion over ten years.

Clean-coal incentives in US Energy Policy Act of 2005

- The Act includes a number of provisions for tax credits, loan guarantees, loans, and direct grants. These incentives are available for existing, under development, and newly-proposed clean coal and gasification projects.
- The Act enables the U.S. Department of Energy to provide US$200 million annually for nine years, from 2006 to 2014, as loan guarantees, loans, and direct grants, to gasification and other clean coal project developers for a total of US$1.8 billion. Of this amount, at least 70 percent must be used for gasification projects.
- There are 'carve-outs' for specific types of projects to receive direct grants. Portions of the funds must be allocated to projects in the Upper Great Plains, Alaska, and the Western United States. A minimum of five of these projects petroleum coke.
- The Act establishes tax credits for up to US$1.3 billion. Of these amounts, up to US$800 million is for IGCC projects, and US$500 million for other advanced coal-based projects. The tax credit for gasification projects for any taxable year is 20 percent of the qualified investment, while the credit for other advanced coal-based projects is 15 percent.

The first $1 billion in new tax credits covers 9 projects – these 7 and 2 not publicly disclosed

Technology	Recipient	Location	Output	Tax Credit
IGCC Bituminous	Duke Energy – Edwardsport IGCC Project	Edwardsport, IN	795 MW	$133.5 million
IGCC Bituminous	Tampa Electric	Polk County, FL	789 MW	$133.5 million
IGCC Lignite	Mississippi Power Company	Kemper County, MS	700 MW	$133 million
Advanced Coal	Duke Energy Cliffside Modernization Projects	Cleveland and Rutherford Counties, NC	1600 MW	$125 million
Advanced Coal	E.ON U.S., Kentucky Utilities Co. and Louisville Gas and Electric	Bedford, KY	1744 MW	$125 million
Gasification	Carson Hydrogen Power, LLC: Carson Hydrogen Power Project	Carson, CA	hydrogen and 390 MW of electricity	N/A
Gasification	TX Energy, LLC: Longview Gasification and Refueling Project	Longview, TX	synthetic gas for chemical feedstock	N/A

In addition, DOE Carbon Sequestration Program has committed $450 million over the 10 years starting FY2007 to seven regional partnerships to validate capture, transport, injection, and long-term storage of CO_2.

Effect of incentives on coal-to-liquids economics

Parameter	Value
Naphtha Production, bbl/day	22,173
Diesel Production, bbl/day	27,819
Net Plant Power, MW_e	124.3
Coal Feed Flow Rate, tons/day	24,533
Elemental Sulfur Production, tons/day	612
Carbon Dioxide Capture, tons/day	32,481

Fischer-Tropsch coal-to-liquids plant in Illinois coal basin, costing $4.5 billion (including interest during construction), analyzed for NETL by R&D Solutions, SAIC, Parsons, & Nexant, April 2007

Incentives were evaluated separately: $0.50/gal subsidy for F-T liquids; loan guarantees; and $130 million investment tax credit.

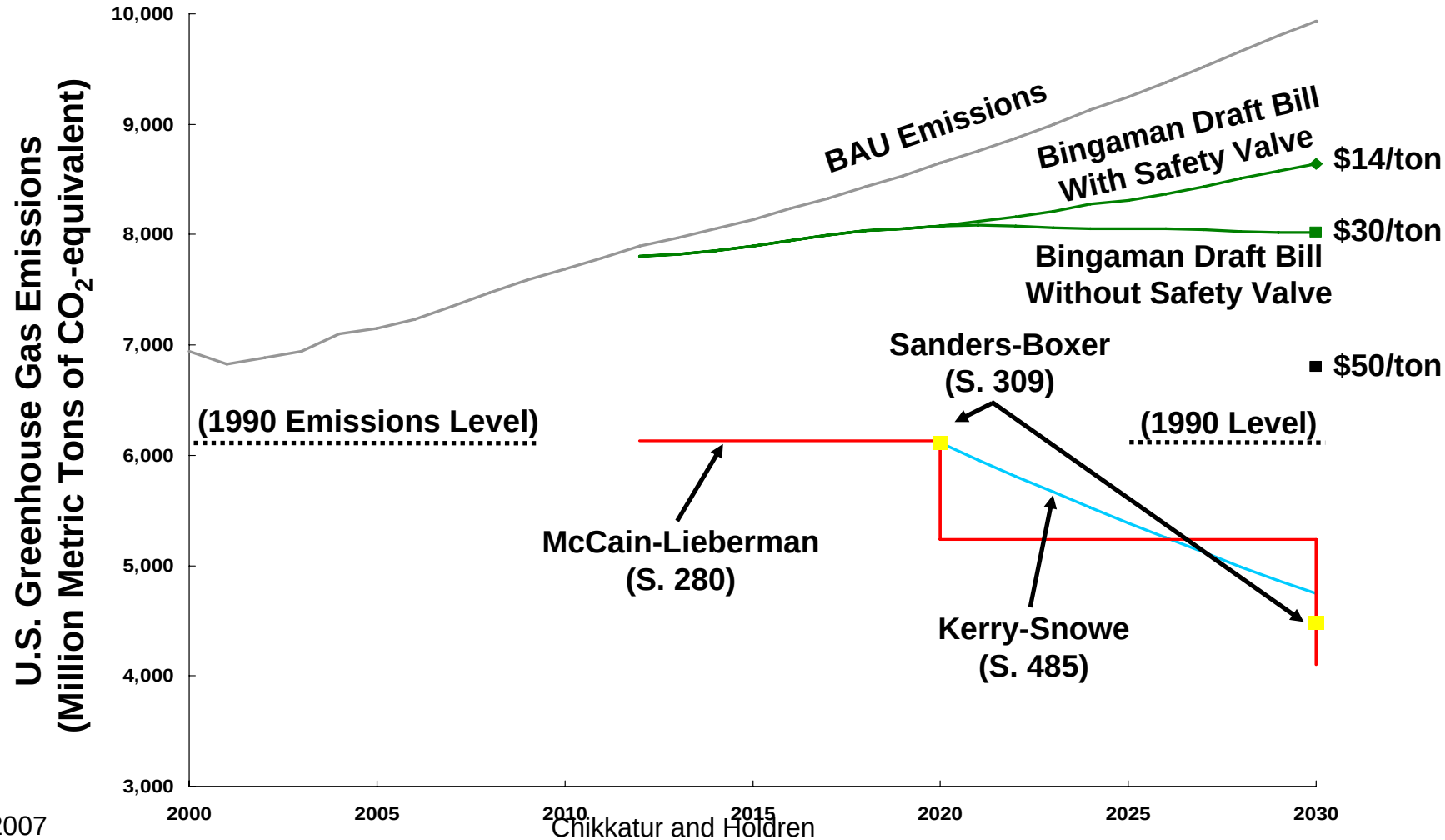
	ROI	NPV at 12%, $MM
Base Case	19.8	1,543
F-T Subsidies	28.7	3,386
Loan Guarantees	31.1	2,067
Investment Tax Credit	20.4	1,625

Characteristics of pending US climate legislation

Topic	S. 280 (Lieberman)	S. 309 (Sanders)	S. 317 (Feinstein)	H.R. 620 (Olver)
Emission reduction/ limitation scheme	Absolute cap on total emissions from all covered entities in the electric power, transportation, industry, and commercial sectors.	Absolute cap on total emissions economy-wide.	Absolute cap on total emissions from covered electric generators.	Absolute cap on total emissions from all covered entities in the electric power, transportation, industry, and commercial sectors.
Specific emissions limits	Beginning in 2012, emissions from covered entities are capped at 6.13 billion metric tons, minus 2012 emissions from non-covered entities. Beginning in 2020, emission cap declines to 5.239 billion metric tons, minus 2020 emissions from non-covered entities. Beginning in 2030, emission cap declines to 4.1billion metric tons, minus 2030 emissions from non-covered entities. Beginning in 2050, emission cap further declines to 2.096 billion metric tons, minus annual emissions from non-covered entities.	Beginning in 2010, emissions economy-wide to be reduced 2% annually. Beginning in 2020, emission cap on economy-wide basis set at 1990 level, with declining emission caps of 26.7% below 1990 levels in 2030 and 53.3% in 2040. Beginning in 2050, emission cap set at 80% below 1990 levels.	Beginning in 2011, emissions from affected electric generators capped at 2006 levels. Beginning in 2015, emissions from affected electric generators capped at their 2001 levels, declining 1% annually until 2020. Beginning in 2020, emission cap declines 1.5% annually.	Beginning in 2012, emissions from covered entities are capped at 6.15 billion metric tons, minus 2012 emissions from non-covered entities. Beginning in 2020, emission cap declines to 5.232 billion metric tons, minus 2020 emissions from non-covered entities. Beginning in 2030, emission cap declines to 3.858 billion metric tons, minus 2030 emissions from non-covered entities. Beginning in 2050, emission cap further declines to 1.504 billion metric tons, minus annual emissions from non-covered entities.

Emissions Targets and Allowance Prices

Comparison of Emissions Targets Proposed by Four Recently Proposed Mandatory Emissions Caps with Estimates of the Effect of Selected Allowance Prices on Emissions



National Commission on Energy Policy April 2007 recommendations for climate-change policy

- Pass legislation in the current Congressional session creating a mandatory, economy-wide program of greenhouse-gas restraints based on emission caps implemented with tradable emission permits.
- Emissions caps to be based on returning to 2006 emission levels by 2020 and reducing to 15% below 2006 levels by 2030.
- Government sets "safety valve" (ceiling) on permit price, starting in 2012 at $10 per tonne of CO_2 and escalating at 5% per year in real terms.

  Safety valve means that, if market price reaches this value, government sells as many additional permits as are demanded at that price.

National Commission on Energy Policy April 2007 recommendations on coal-technology policy

- **Emphasize actual deployment of carbon capture and storage (CCS). Projects with CCS should get bonus allowances under a GHG trading program that are <u>at least equal in value</u> to renewable energy production tax credit.**

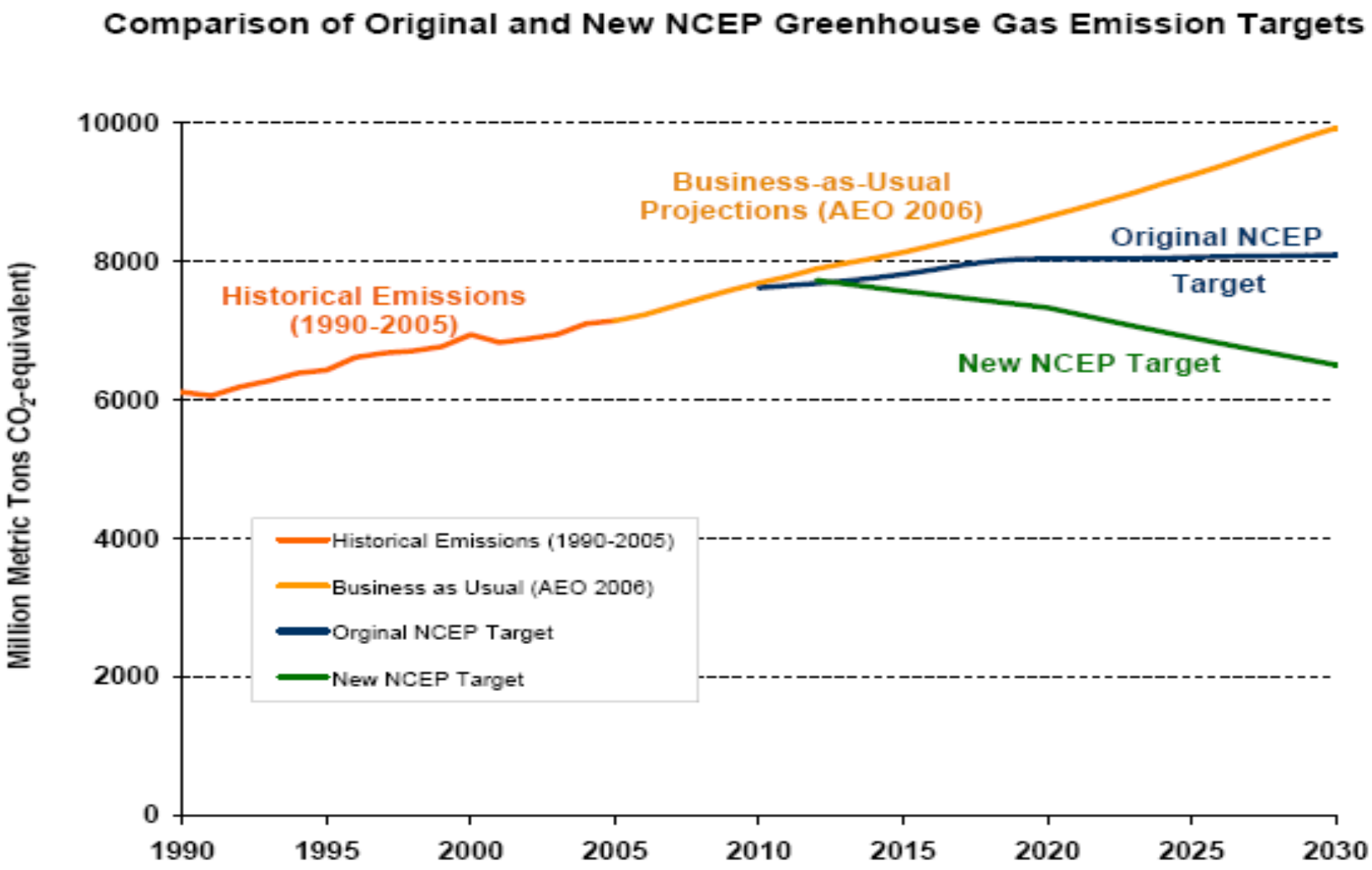
- **Limit public funding or subsidies for any new coal plants going forward to projects that actually include CCS. CCS must be included from the outset in any taxpayer-supported coal-to-liquids projects.**

- **Explore carbon capture options for non-IGCC plants.**

- **Direct EPA to develop effective regulatory protocols for long-term carbon storage as soon as possible (recognizing that midcourse corrections will likely be needed as experience is gained).**

- **Ensure that new coal plants built without CCS are not "grandfathered" (i.e., awarded free allowances) in any future GHG trading program.**

US emissions trajectory under April 2007 NCEP recommendations



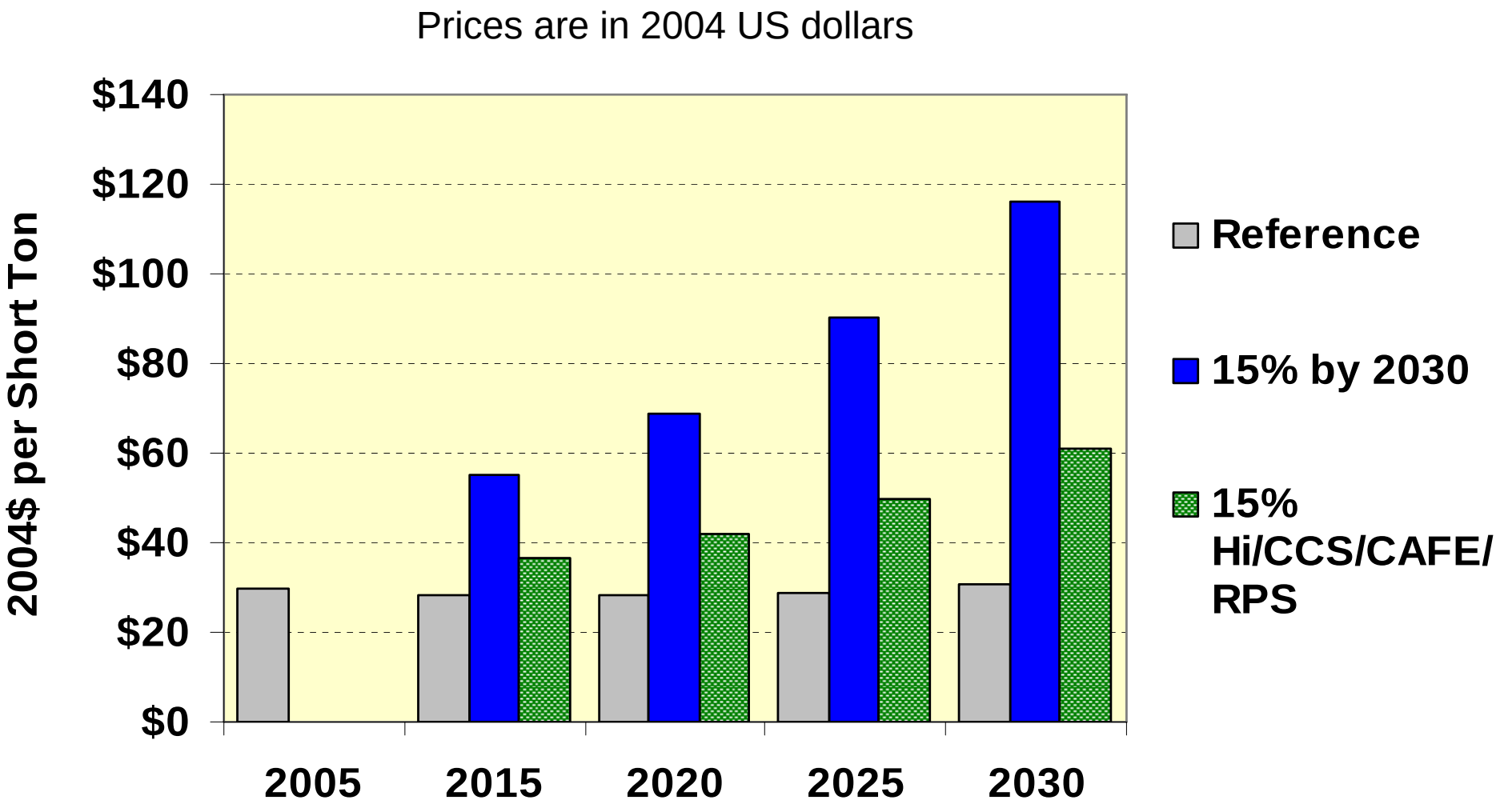
Effect of NCEP CO2 target & supplementary policies on coal price & utilization to 2030

	Supplementary Policies
15% below by 2030	No supplementary policies EIA “reference case” technology assumptions
15% Hi/CCS	EIA “Hi-tech” assumptions 10 GW of CCS demonstration plants 1.9¢ per kWh tax credit for CCS
15% Hi/CCS/CAFE	Hi/CCS + CAFE increases to 41 mpg by 2030 for new light-duty vehicles
15% Hi/CCS/CAFE/RPS	Hi/CCS/CAFE + 15% renewable portfolio standard

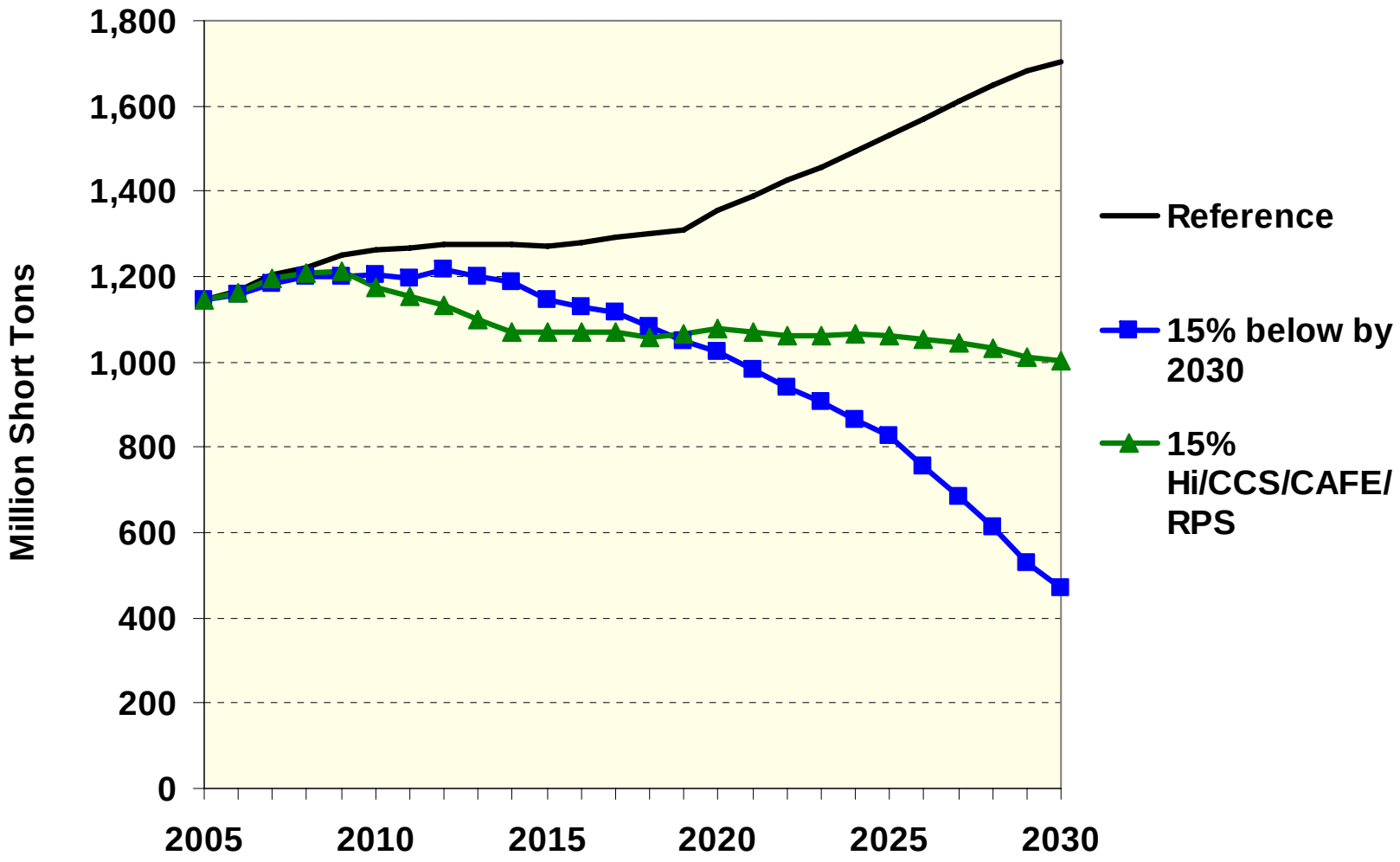
The cases were run without the safety valve to determine the cost of meeting the target, and the impact of supplementary policies on the allowance price.

The AEO 2006 is used as the reference case for the analysis.

Coal price to electric sector for no policy and 15% 2030 target with & without advanced technology



US coal production for no policy and 15% 2030 target with & without advanced technology



Thank you!