Worldwide Pollution Control Association

Michigan Coal to Gas Seminar

June 5-6, 2012

Visit our website at www.wpca.info

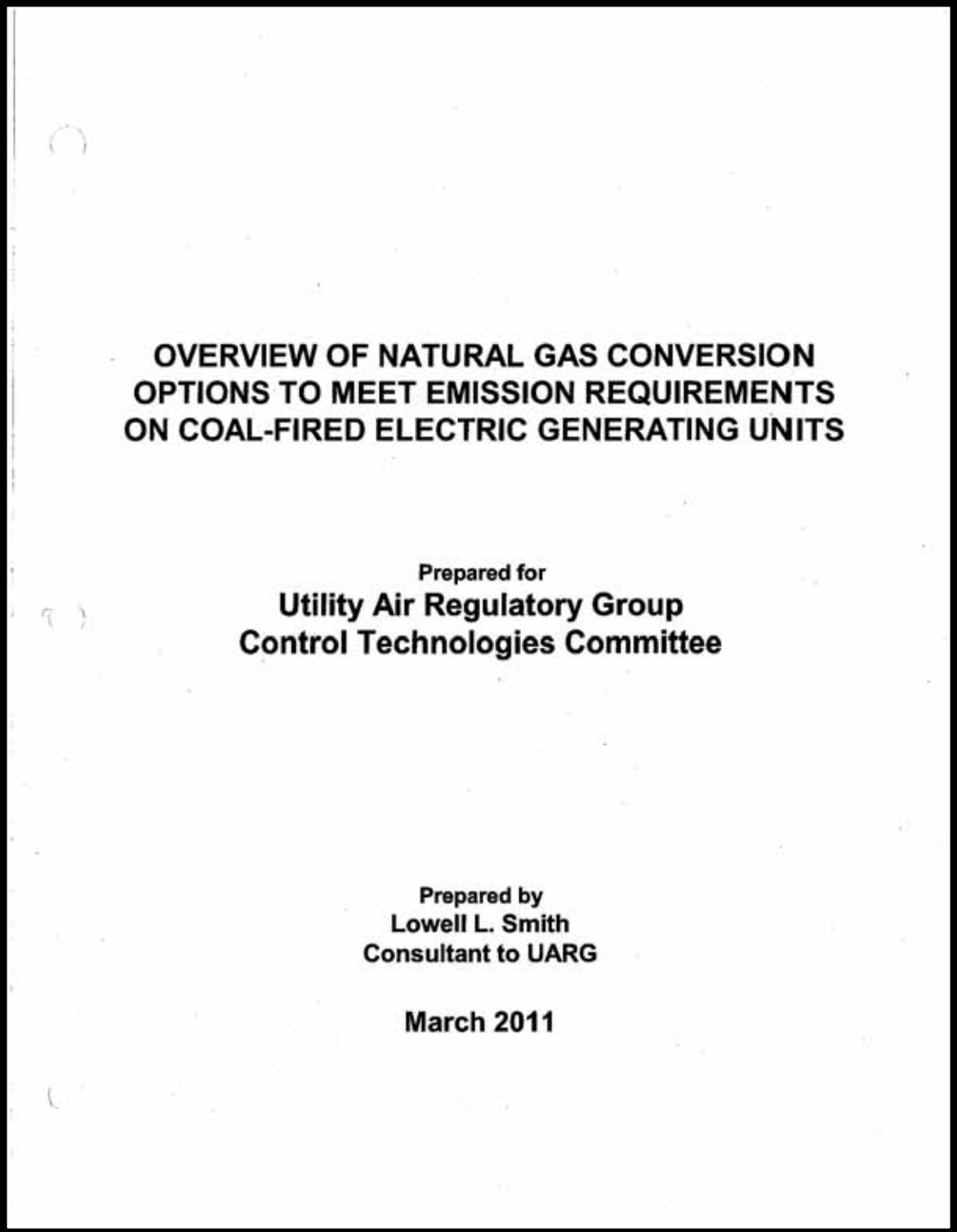
Coal to Gas Conversion

A Few Thoughts

Scott Evans, Clean Air Engineering

A few good
resources...

A few good resources...

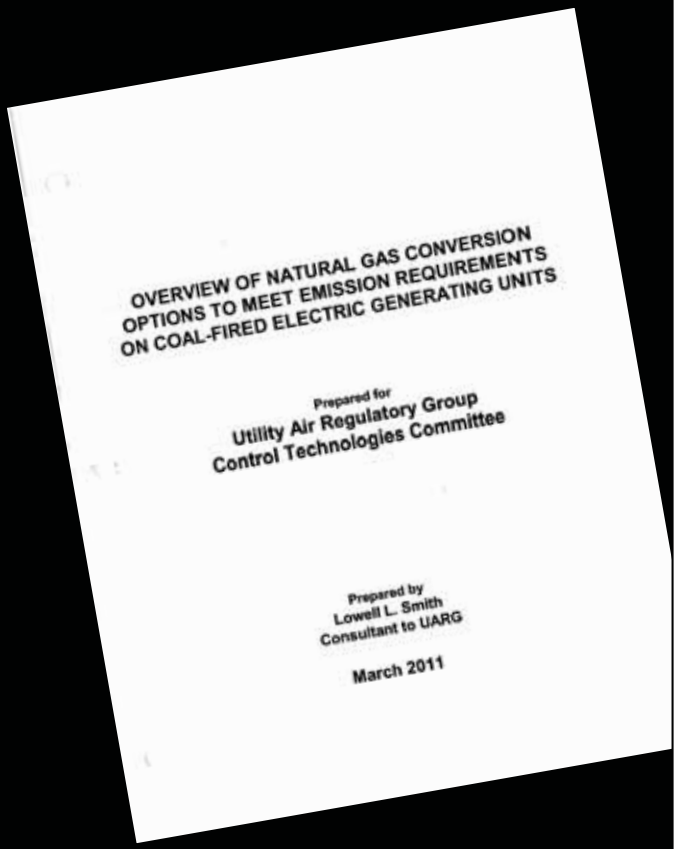


OVERVIEW OF NATURAL GAS CONVERSION OPTIONS TO MEET EMISSION REQUIREMENTS ON COAL-FIRED ELECTRIC GENERATING UNITS

Prepared for
Utility Air Regulatory Group
Control Technologies Committee

Prepared by
Lowell L. Smith
Consultant to UARG

March 2011



OVERVIEW OF NATURAL GAS CONVERSION OPTIONS TO MEET EMISSION REQUIREMENTS ON COAL-FIRED ELECTRIC GENERATING UNITS

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Consultant to UARG

March 2011

White Paper
MS-14

Natural Gas Conversions of Existing Coal-Fired Boilers

Authors:
F.J. Binkiewicz Jr., P.E.
R.J. Kleisley
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J.E. Monacelli
D.A. Roth
D.K. Wong

Babcock & Wilcox
Power Generation Group, Inc.
Barberton, Ohio, U.S.A.

B&W babcock & wilcox power generation group

A few good resources...

FEASIBILITY AND COST OF CONVERTING OIL- AND
COAL-FIRED UTILITY BOILERS TO
INTERMITTENT USE OF NATURAL GAS

James A. Fay, Dan S. Golomb, Savvakis C. Zachariades

Energy Laboratory Report No. MIT-EL 86-009

December 1986

A few good resources...

A few good resources...

BERNSTEINRESEARCH

U.S. Utilities: Coal-Fired Generation Is Squeezed in the Vice of EPA Regulation; Who Wins and Who Loses?

OCTOBER 2010

EPA emissions regulations will speed coal plant retirements, raise prices – and benefit survivors

Under a court order to regulate hazardous air pollutants from coal-fired power plants by November 2011, EPA is readying tough new emissions standards for mercury and acid gases; the Clean Air Act requires that all coal plants comply by November 2014

To control hazardous air pollutants, the Clean Air Act requires "maximum achievable control technology," a costly combination of emissions controls; for many older, smaller coal plants, the cost of these retrofits will be prohibitive, forcing widespread retirements by 2015

We calculate that plants supplying 15% of U.S. coal-fired generation will cease operation; net of new coal plants coming on line, coal-fired generation could fall by 9% by 2015; utility demand for coal will drop commensurately; gas-fired generation, and utility demand for gas, will rise

This loss of coal-fired capacity will raise prices for energy and capacity, benefiting competitive generators whose nuclear or EPA-compliant coal plants are unaffected: FirstEnergy (FE), Exelon (EXC), Constellation (CEG), Mirant (MIR), PPL (PPL), PSEG (PEG), and Allegheny (AYE)

A few good resources...

May 2012

Coal to Gas Switching: Are We Done Yet?

Oil & Gas - North American Energy
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Advantages of Natural Gas for New Generation

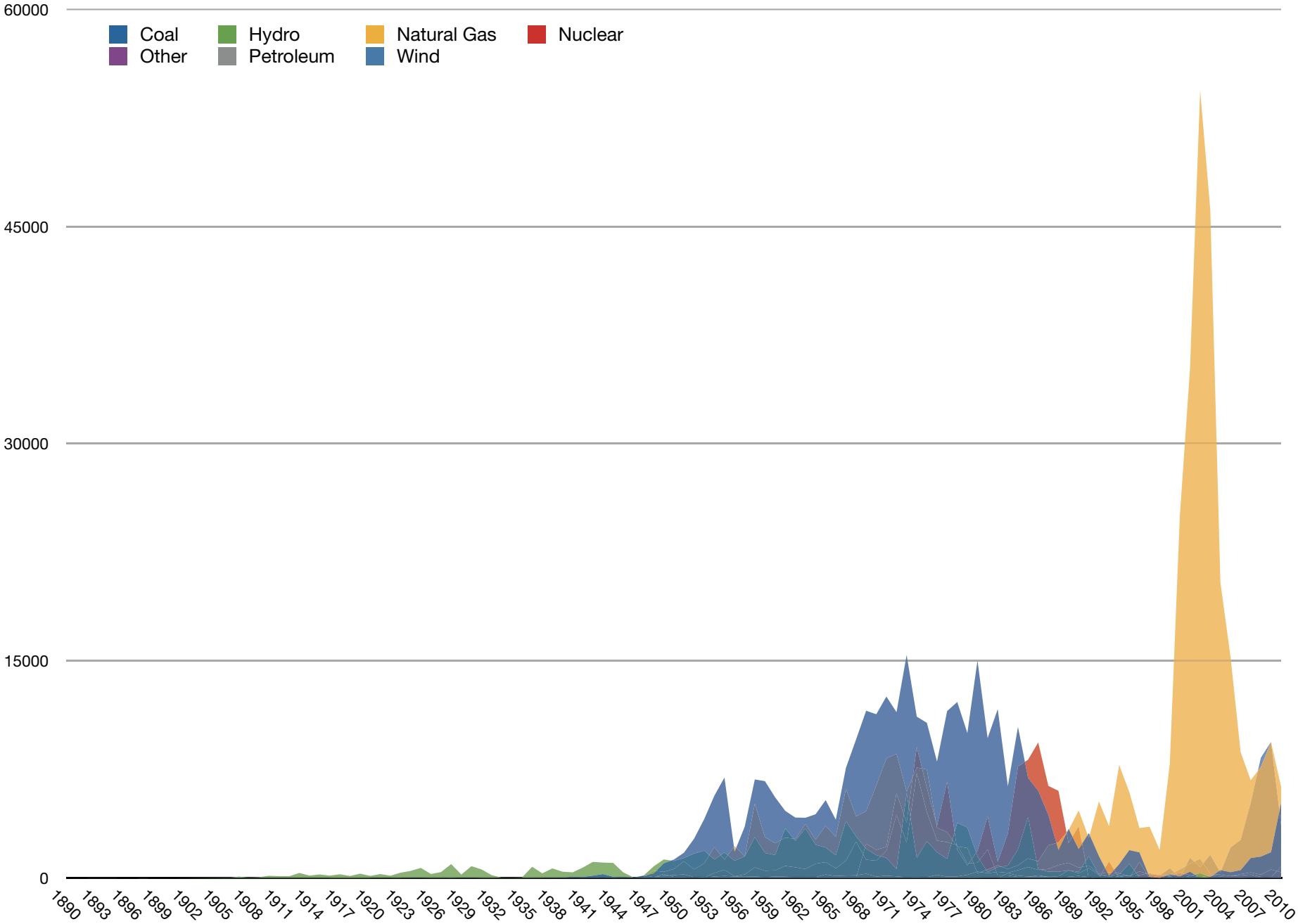
Substantially lower SO_2, PM and CO_2 emissions

Lower capital costs (half that of coal)

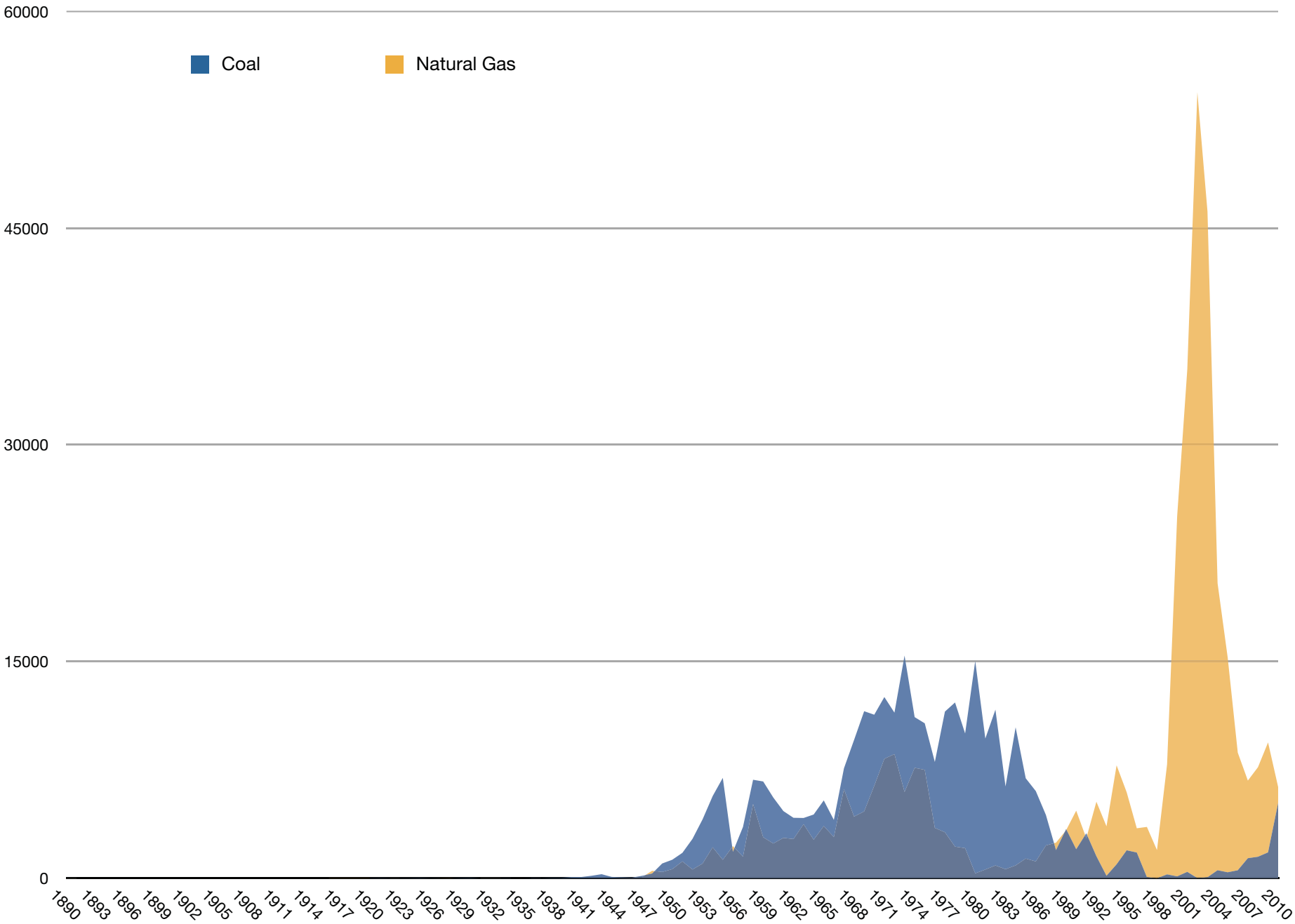
Quicker construction and commissioning (2-3 years vs 5-6 for coal)

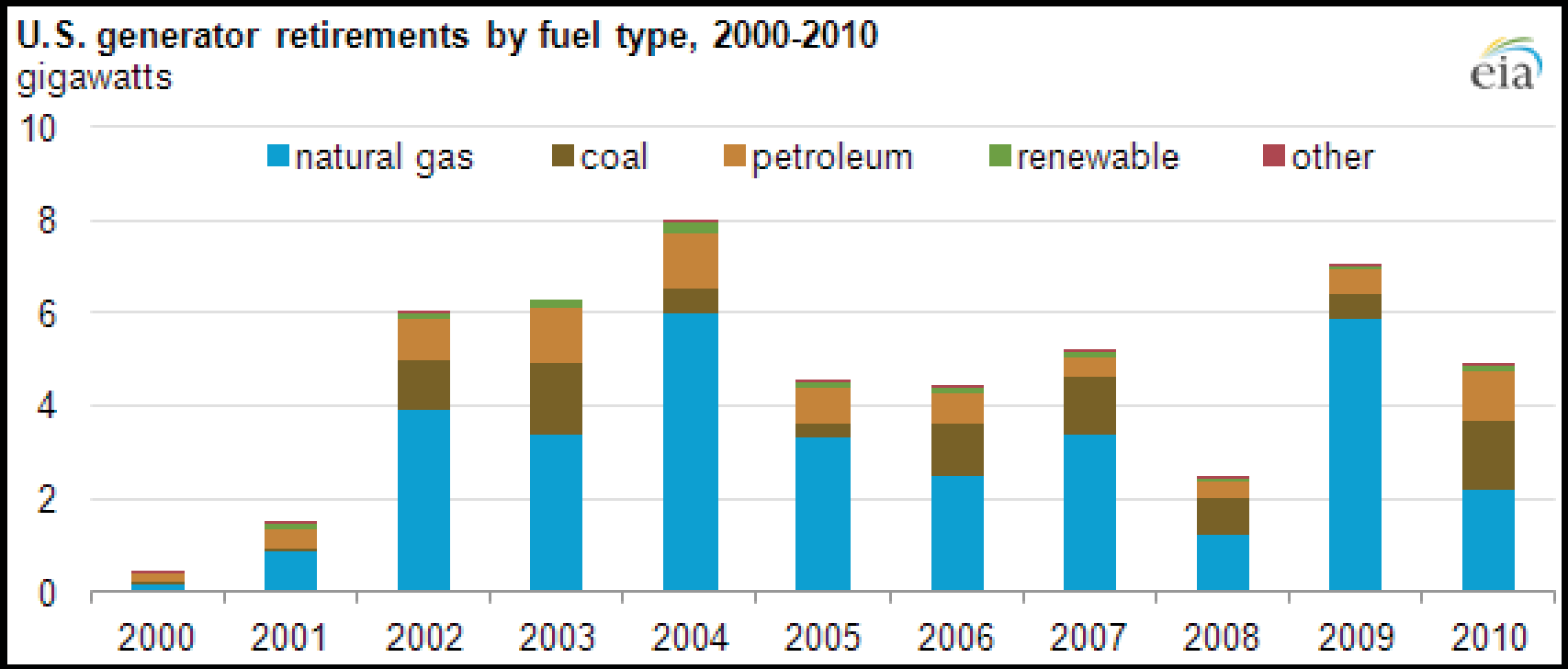
Suitability for small scale and modular construction

Current Capacity by Initial Year of Operation and Fuel Type



Current Capacity by Initial Year of Operation and Fuel Type




U.S. generator retirements by fuel type, 2000-2010
gigawatts
eia
10
8
6
4
2
0
natural gas
coal
petroleum
renewable
other
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

POTENTIAL GAS COMMITTEE REPORTS UNPRECEDENTED INCREASE IN MAGNITUDE OF U.S. NATURAL GAS RESOURCE BASE

POTENTIAL GAS COMMITTEE REPORTS UNPRECEDENTED INCREASE IN MAGNITUDE OF U.S. NATURAL GAS RESOURCE BASE

GOLDEN, Colo., June 18, 2009 – The Potential Gas Committee (PGC) today released the results of its latest biennial assessment of the nation's natural gas resources, which indicates that the United States possesses a total resource base of 1,836 trillion cubic feet (Tcf). This is the highest resource evaluation in the Committee's 44-year history. Most of the increase from the previous assessment arose from reevaluation of shale-gas plays in the Appalachian basin and in the Mid-Continent, Gulf Coast and Rocky Mountain areas.

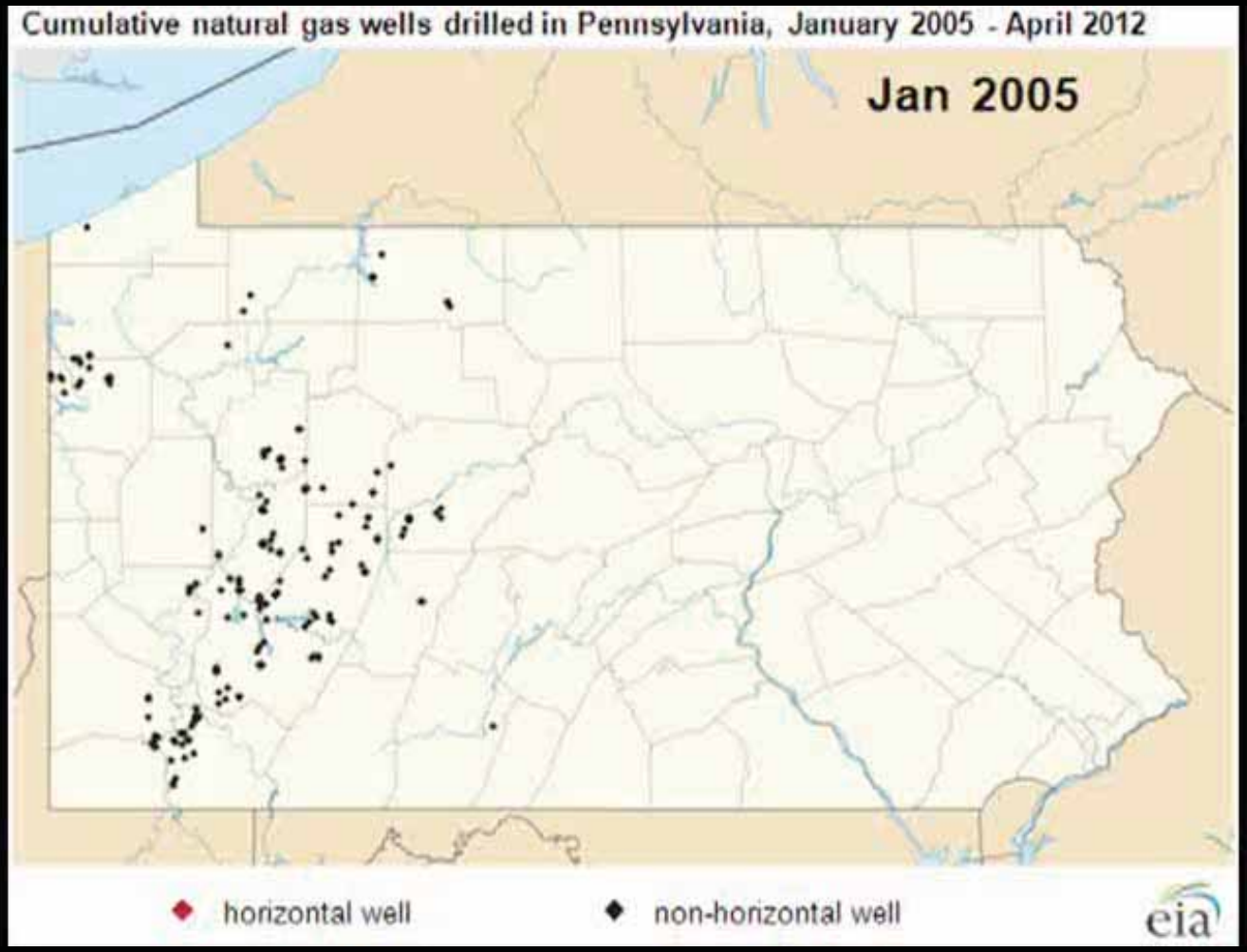
"The PGC's year-end 2008 assessment reaffirms the Committee's conviction that abundant, recoverable natural gas resources exist within our borders, both onshore and offshore, in all types of reservoirs," said Dr. John B. Curtis, Professor of Geology and Geological Engineering at the Colorado School of Mines and Director of the Potential Gas Agency there, which provides guidance and technical assistance to the Potential Gas Committee.

Dr. Curtis cautioned, however, that the current assessment assumes neither a time schedule nor a specific market price for the discovery and production of future gas supply. "Estimates of the Potential Gas Committee are 'base-line estimates' in that they attempt to provide a reasonable appraisal of what we consider to be the 'technically recoverable' gas resource potential of the United States," he explained.

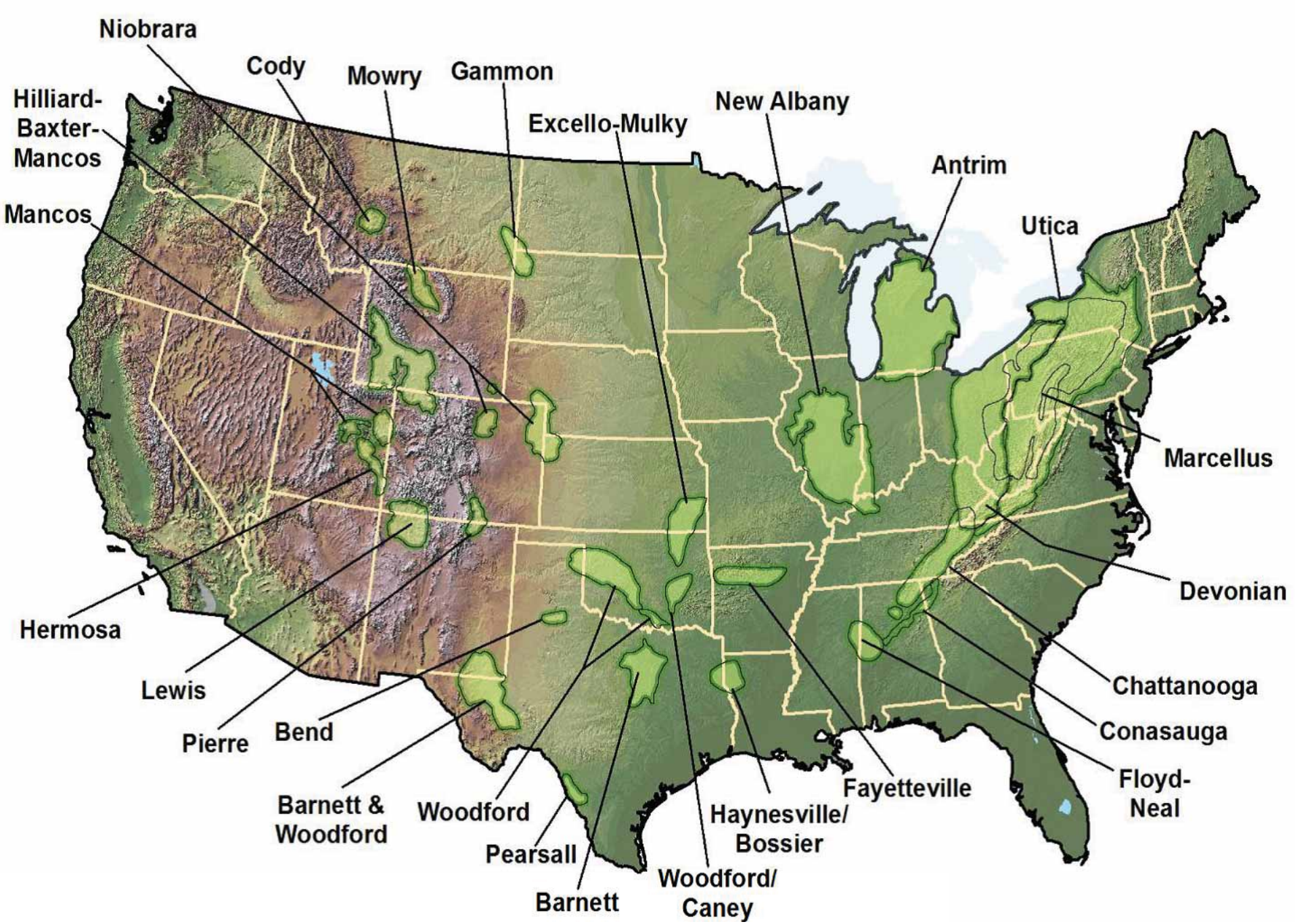
The Committee's year-end 2008 assessment of 1,836 Tcf (statistically aggregated mean value) consists of 1,673 Tcf of gas attributable to traditional reservoirs and 163 Tcf in coalbed reservoirs. Compared to year-end 2006, traditional resources increased by nearly 519 Tcf (45%), while coalbed gas resources decreased by 3 Tcf (1.9%), resulting in a net increase in total potential resources of 515 Tcf (39%). (See accompanying Table 1.)

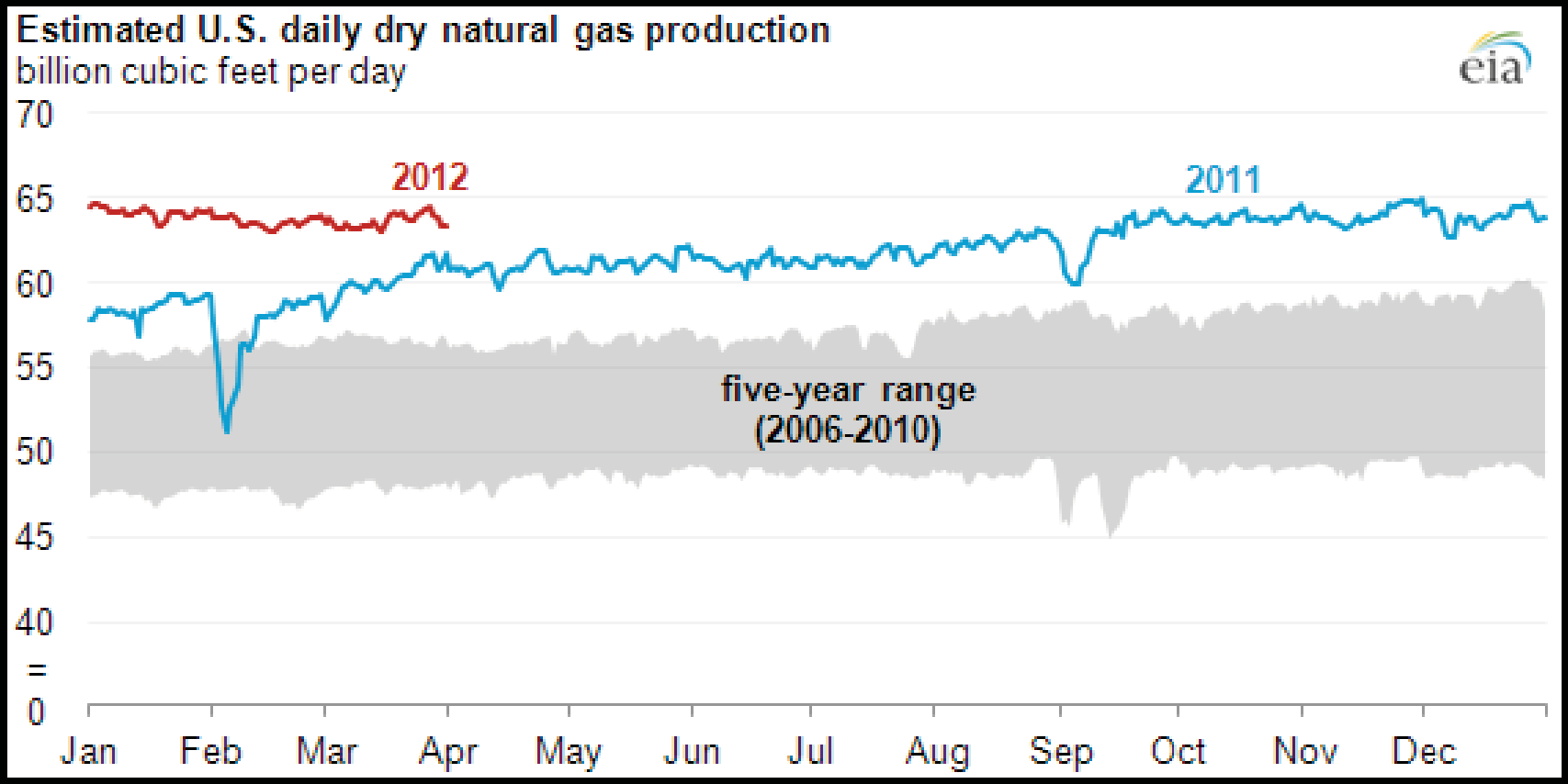
These changes have been assessed in addition to the 41 Tcf of marketed domestic natural gas production recorded during the two-year period since the Committee's previous report.

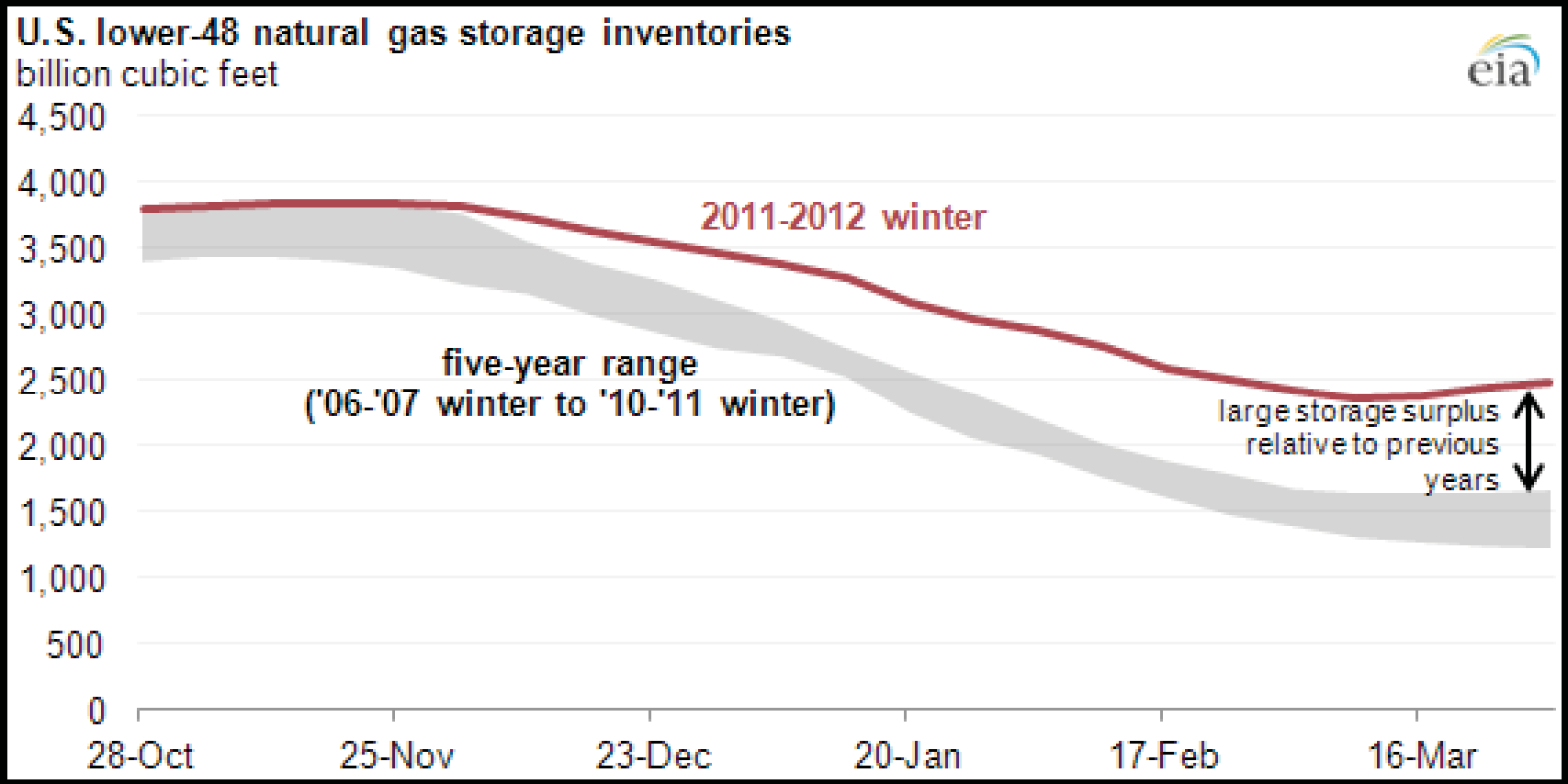
When the PGC's results are combined with the U.S. Department of Energy's latest available determination of proved gas reserves, 238 Tcf as of year-end 2007, the United States has a total available *future supply* of 2,074 Tcf, an increase


Cumulative natural gas wells drilled in Pennsylvania, January 2005 - April 2012
Jan 2005
horizontal well
non-horizontal well
eia

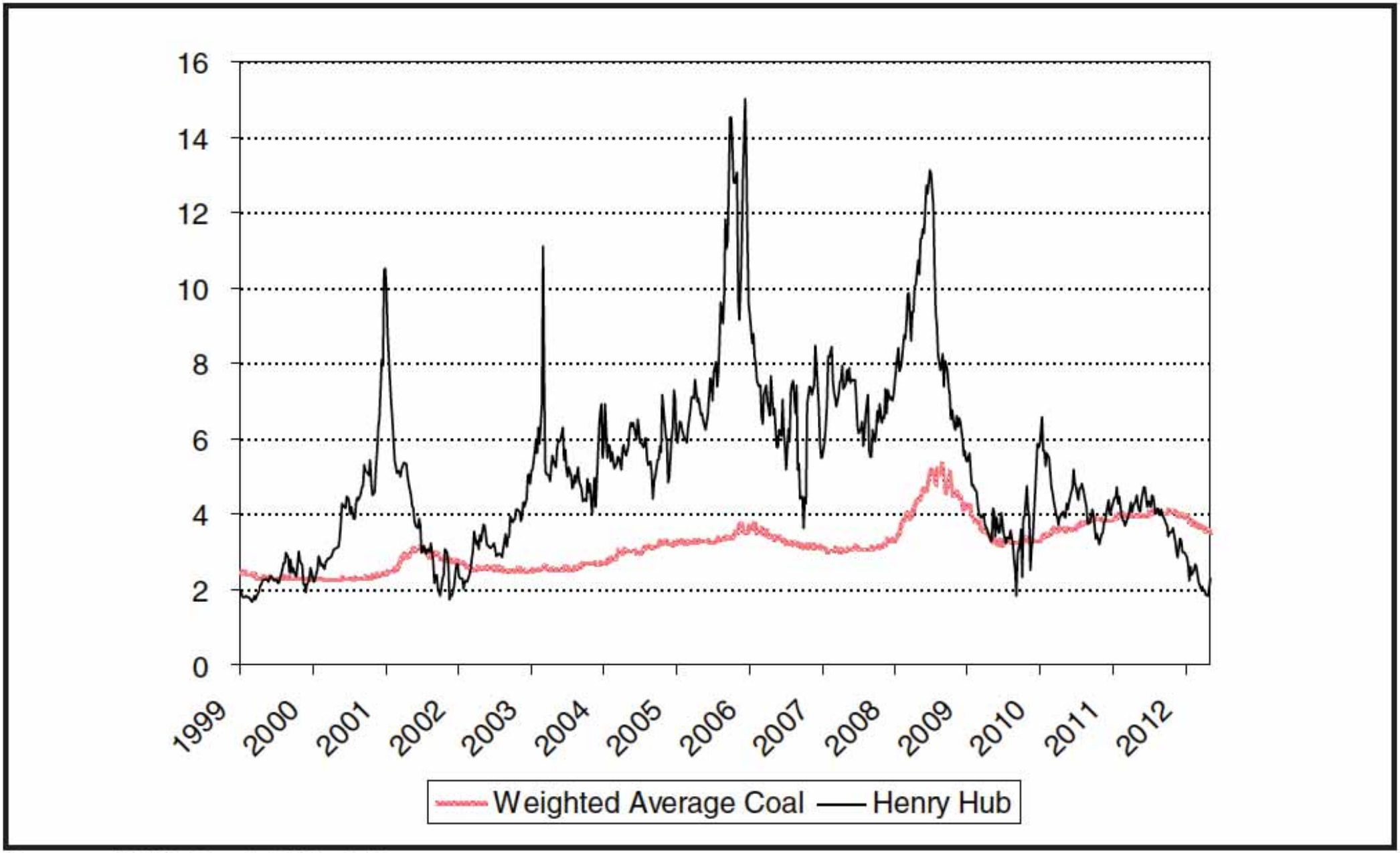
U.S. Shale Gas Plays




Estimated U.S. daily dry natural gas production
billion cubic feet per day
eia
70
65
60
55
50
45
40
=
0
2012
2011
five-year range
(2006-2010)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

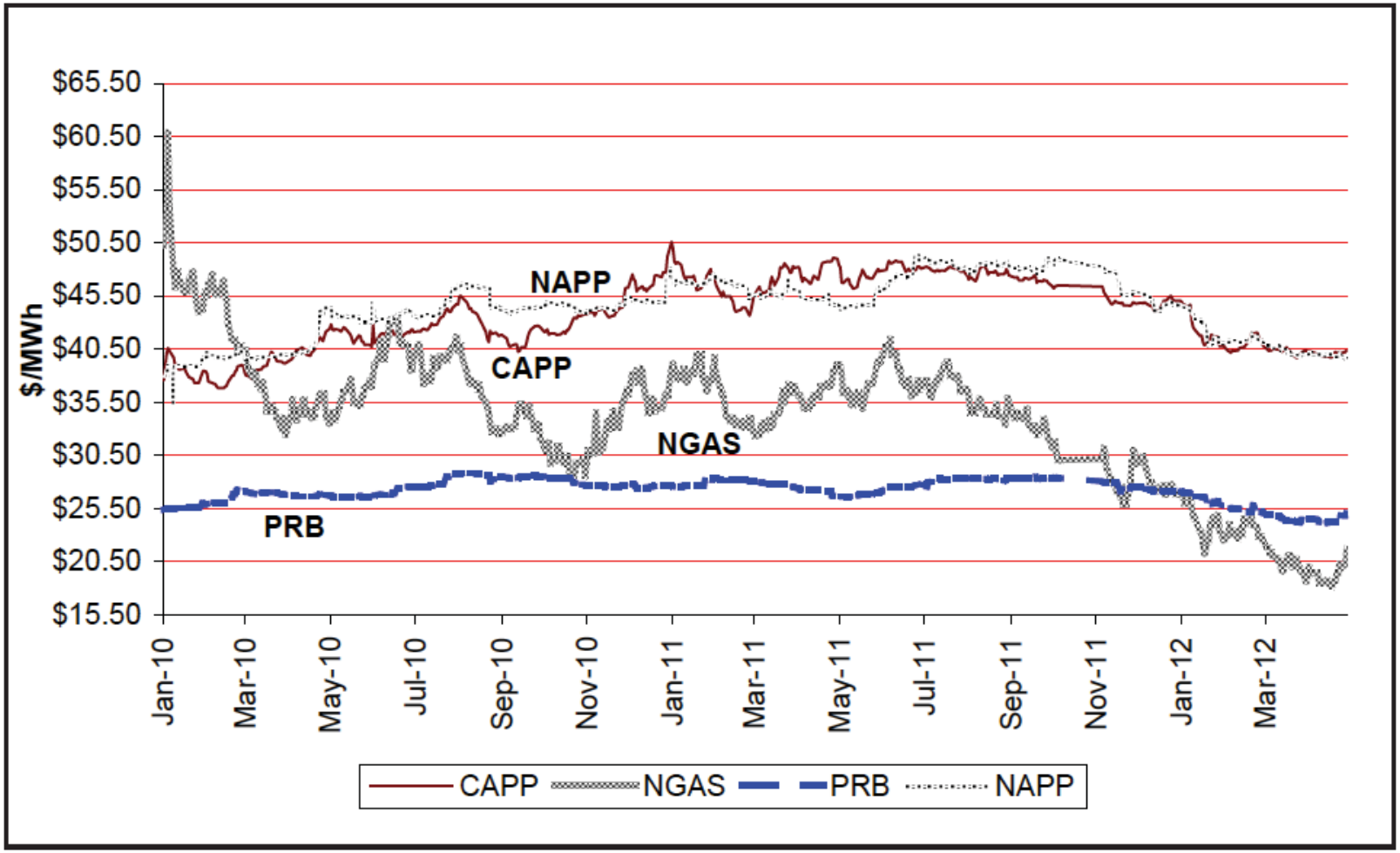

U.S. lower-48 natural gas storage inventories
billion cubic feet
eia
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
2011-2012 winter
five-year range
('06-'07 winter to '10-'11 winter)
large storage surplus
relative to previous
years
28-Oct
25-Nov
23-Dec
20-Jan
17-Feb
16-Mar

Coal vs NG Prices ($/mmBtu)



Source: BMO Capital Markets

Increasing Competitiveness of Natural Gas by Coal Basin Type

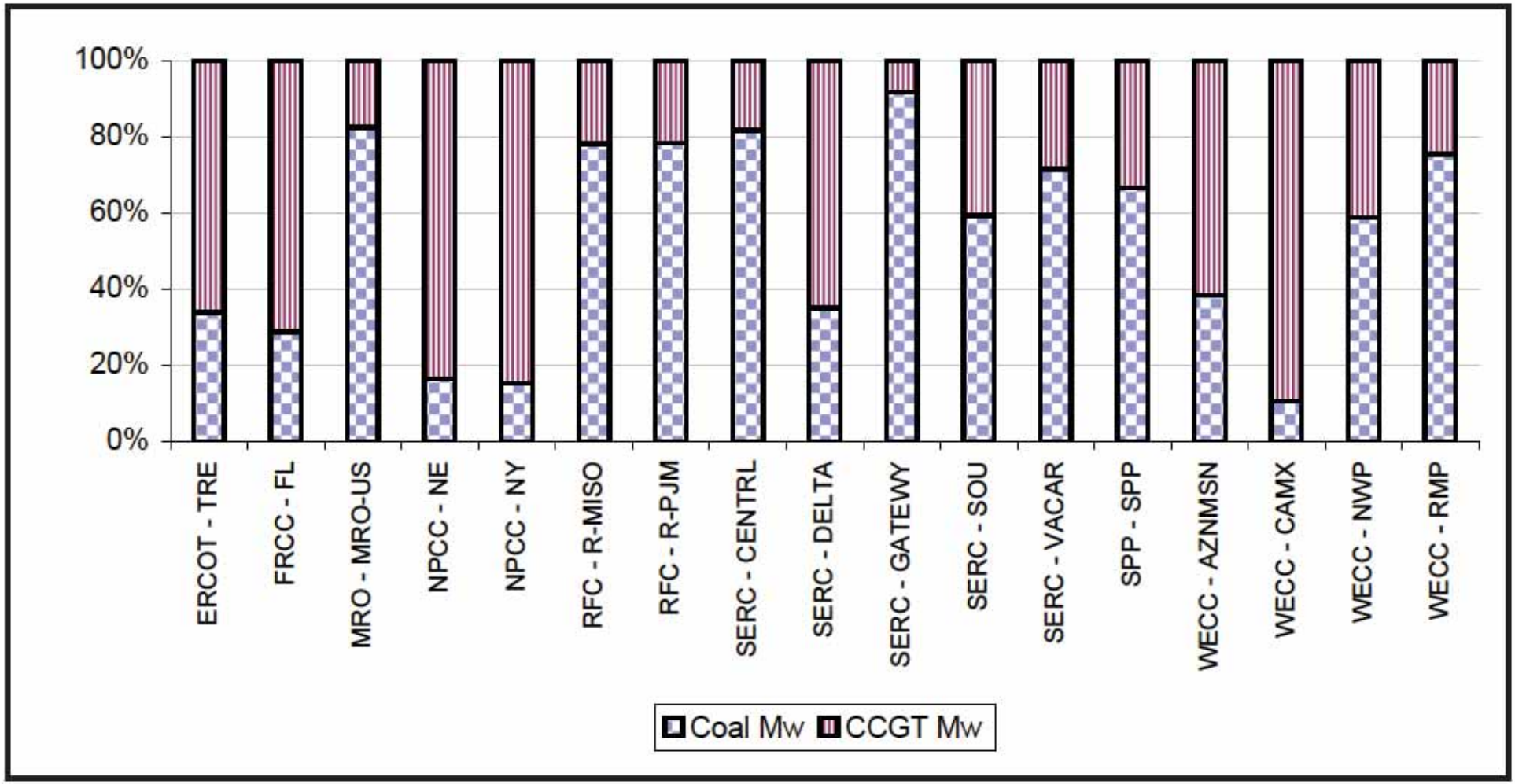


Notes:

1. Near month coal prices and spot gas prices used to compare power costs.
2. Average coal and gas plant heat rate assumed to be 10.5 and 7.5 mmBtu/MWh, respectively.
3. Transportation costs of $25/Ton for CAPP and NAPP Coal and $22.5/Ton for PRB coal
4. Non-Fuel total O&M costs of $7.8, $8.0, $6.4 and $4.5 for CAPP, NAPP, PRB and Gas-fired plants, respectively (C$/MWh).

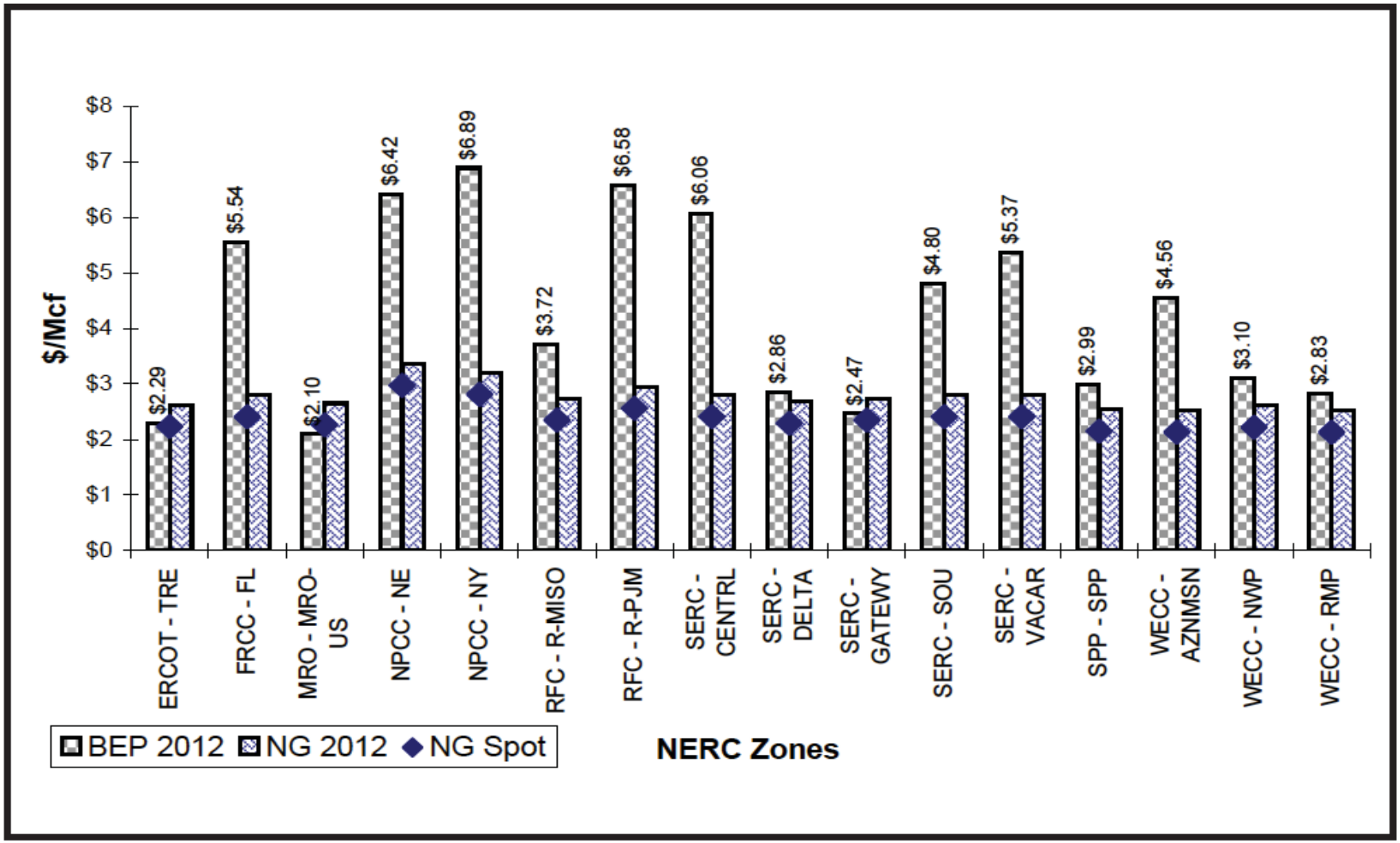
Source: EIA and BMO Capital Markets

Coal and Gas Generation Mix by NERC Subzone



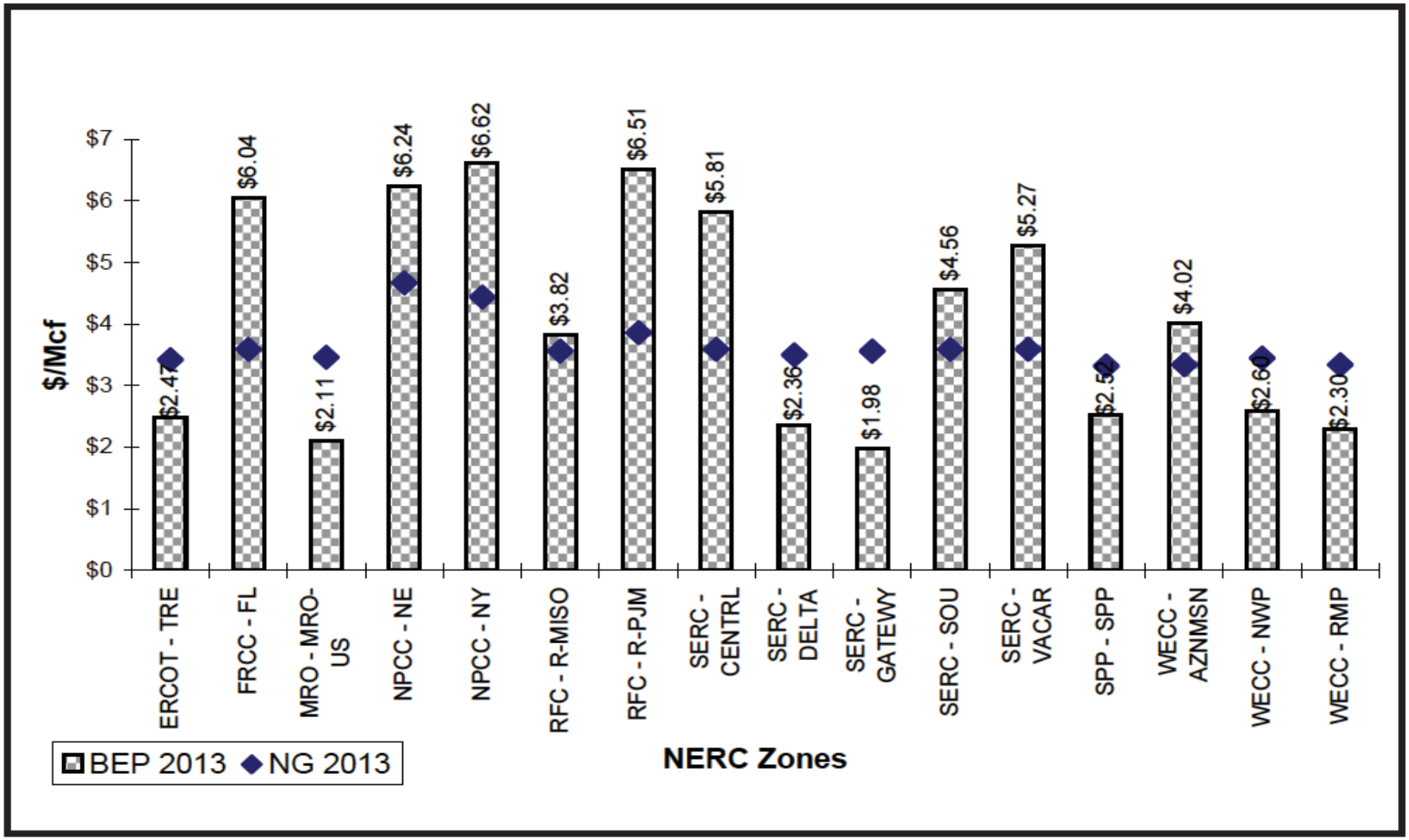
Source: SNL and BMO Capital Markets estimates
See glossary for description of regions.

Coal to Gas Price Parity
2012



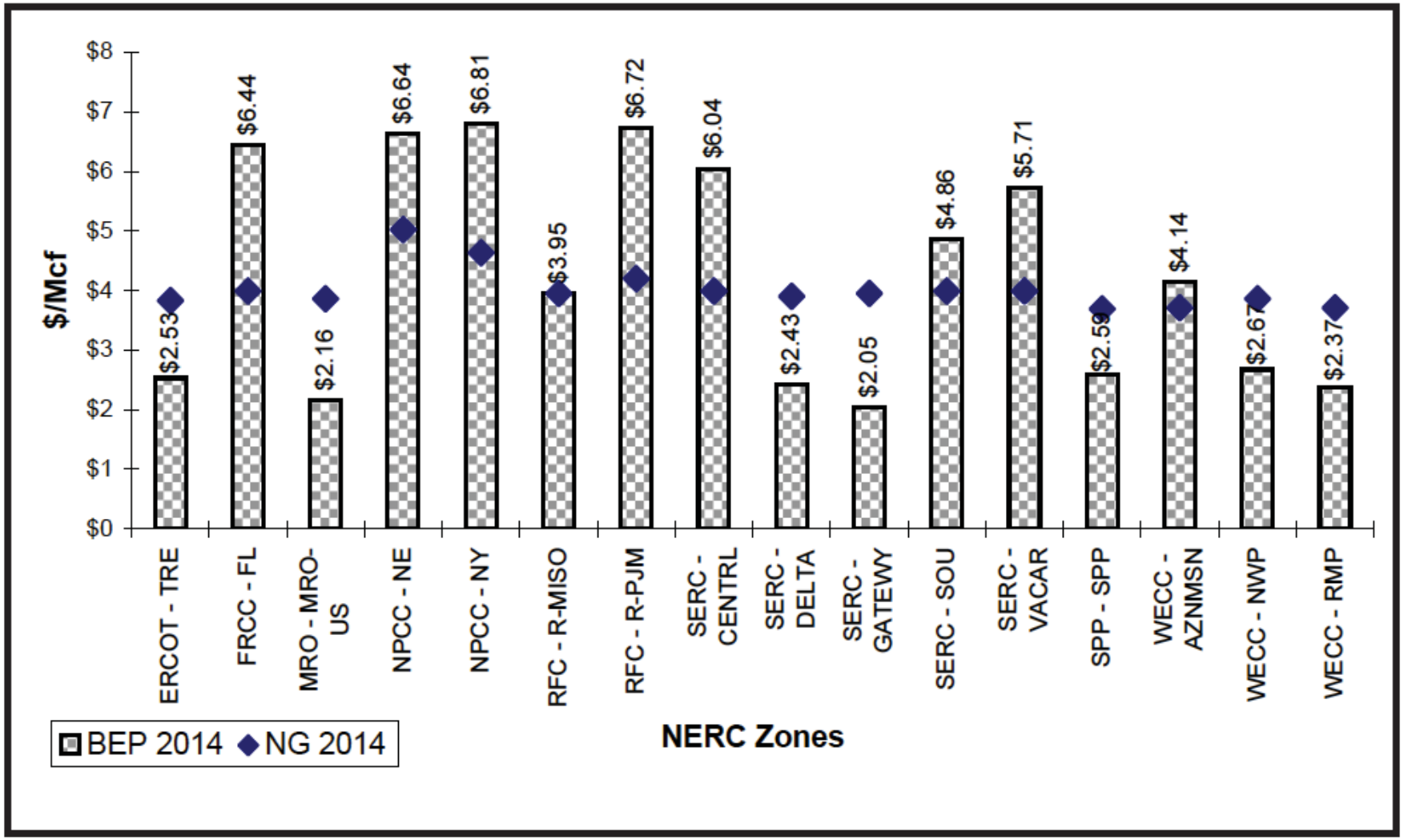
Source: EIA, SNL and BMO Capital Markets estimates

Coal to Gas Price Parity
2013



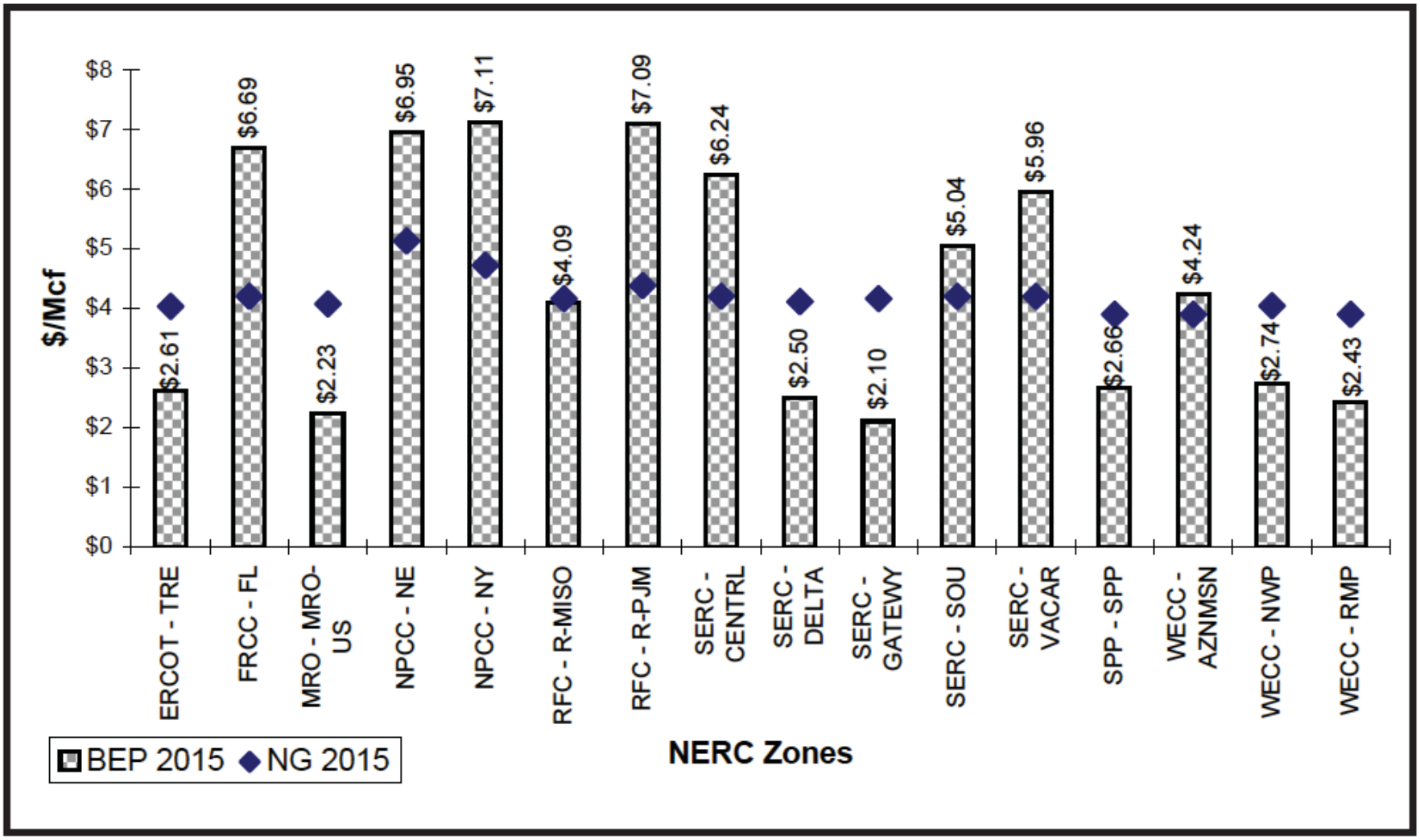
Source: EIA, SNL and BMO Capital Markets estimates

Coal to Gas Price Parity
2014



Source: EIA, SNL and BMO Capital Markets estimates

Coal to Gas Price Parity
2015



Source: EIA, SNL and BMO Capital Markets estimates

NOW IS THE TIME!

COAL CHEAP!

Coal coarse, measure warranted and no disappointment at **TEN MILE WORKS.** We are selling **FOR CASH** at **$4,00** per hundred, and extend the time at this price till the middle of October and hope to continue all Fall. We follow this as a business, and understand the wants of the people, and employ no hands but those skilled in the business. Works one and one-half miles from Waynesburg, close by Lantz's old mill—along New Pike.

R. A. SAYERS.

Sept. 7, 1868.

PLEASE POST UP IN A CONSPICUOUS PLACE.


ORDER COAL NOW
UNITED STATES
FUEL ADMINISTRATION


So Clean-
So Carefully-
Prepared
PHONE US TODAY FOR
A FULL SUPPLY OF
THIS TRULY
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KING OF ANTHRACITE
J. W. WOLGEMUTH ESTATE
COAL, GRAIN & FEED
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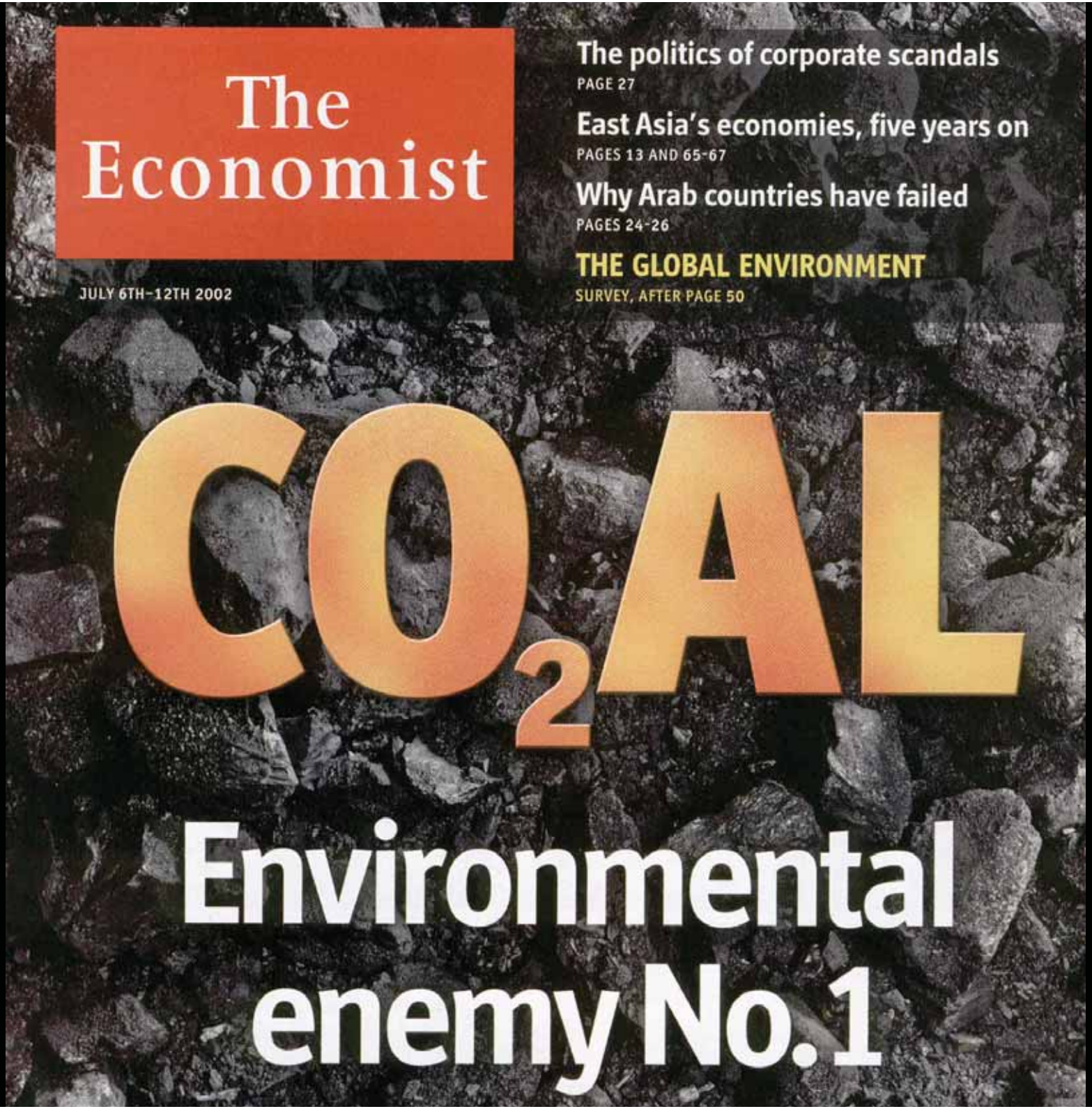
Rheems, Pa.
For your protection, you will find CROWN COAL Tags in your coal
CROWN
COAL
KING OF ANTHRACITE


GREEN
JOBS
NO COAL
sky


TIME IS UP
ACT NOW
COAL IS Dirty!
Clean Energy
STOP COAL.
» Solve Global Warming


QUIT
COAL


NO COAL
JOBS
JOBS
JOBS


The Economist
The politics of corporate scandals
PAGE 27
East Asia's economies, five years on
PAGES 13 AND 65-67
Why Arab countries have failed
PAGES 24-26
THE GLOBAL ENVIRONMENT
SURVEY, AFTER PAGE 50
JULY 6TH-12TH 2002
CO2AL
Environmental enemy No.1

student union presents

THE GREAT COAL DEBATE

moderated by

BRYAN WALSH *of* TIME

Utility MACT (MATS)
40 CFR 63 Subpart UUUUU

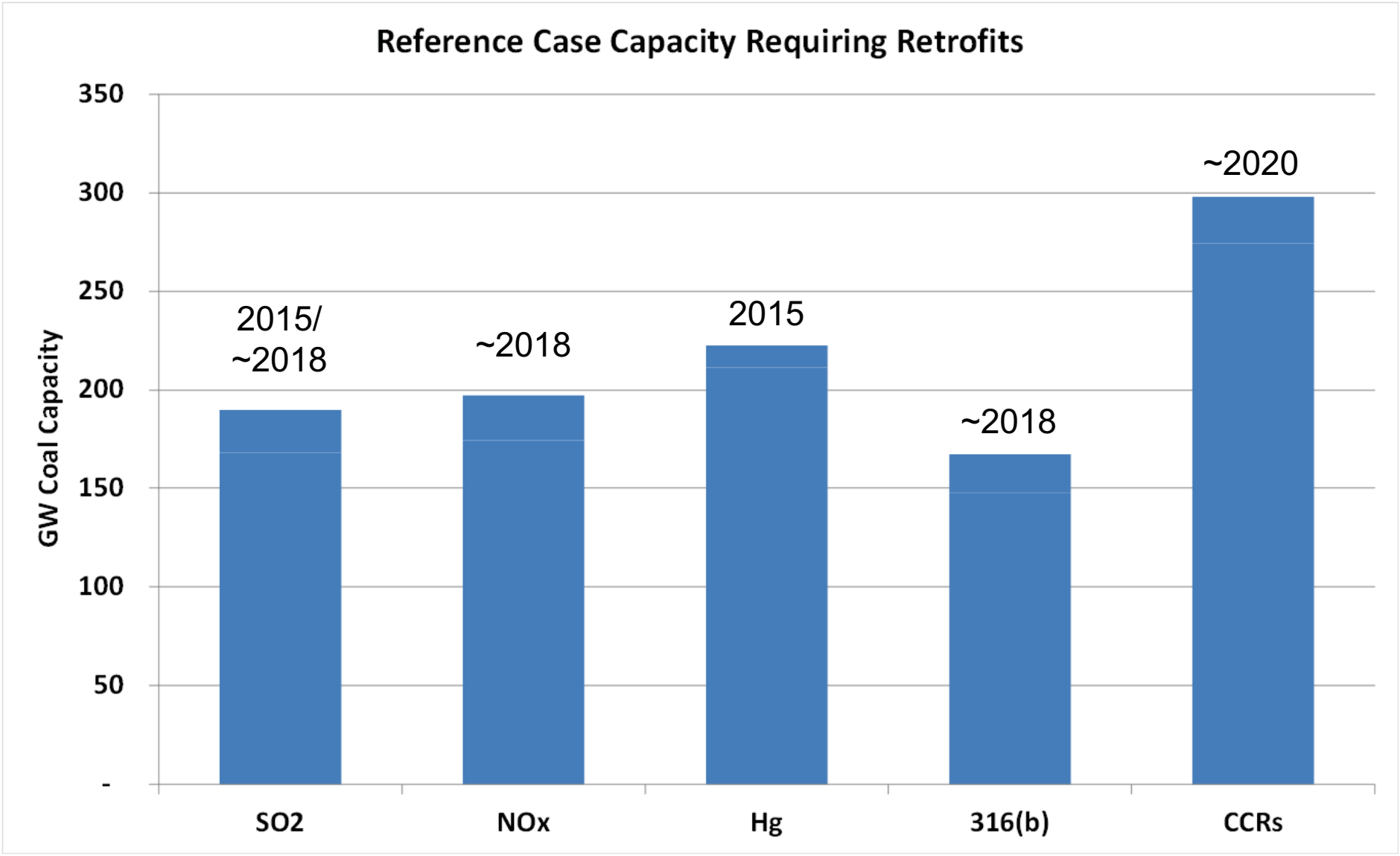
Cross-State Air Pollution Rule (CSAPR)
Currently stayed

New Source Performance Standard (NSPS) for Greenhouse Gas Emissions from Electric Utility Generating Units
40 CFR 60 Subpart TTTT (Proposed)

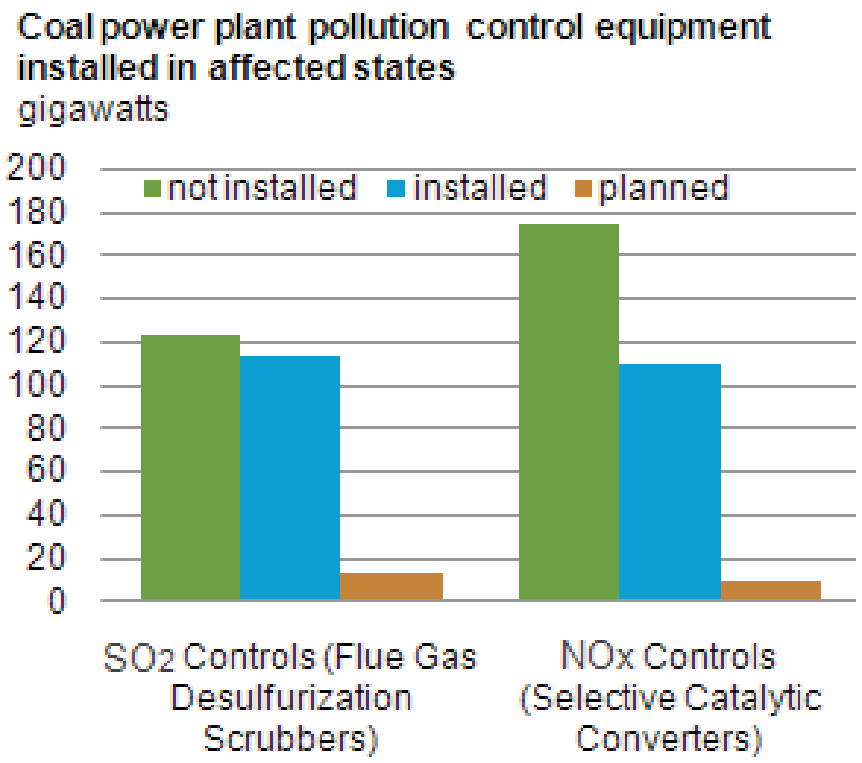
316(b) Cooling Water Intake regulations
Proposed - Final Expected Late July

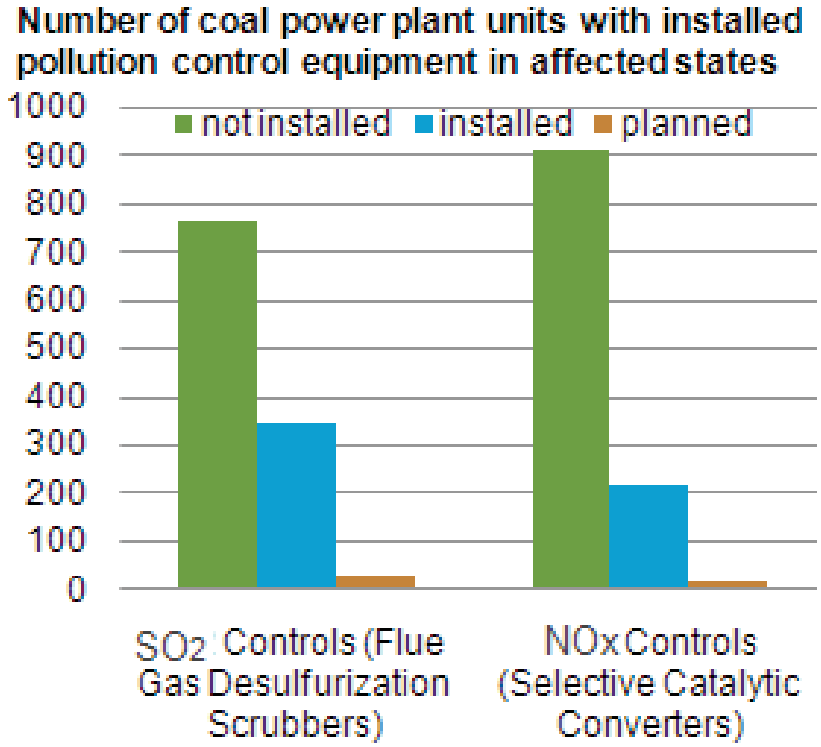

National Ambient Air Quality Standard (NAAQS) for PM 2.5 - Expected Summer
Coal-Combustion Residuals (CCR) Rule Proposed - Final Expected This Year
Regional Haze SIPs and FIPs Finalized This Year

Retrofit Estimates



Installed vs Not Installed Controls





Coal-fired plants without controls...

40% are over 50 years old

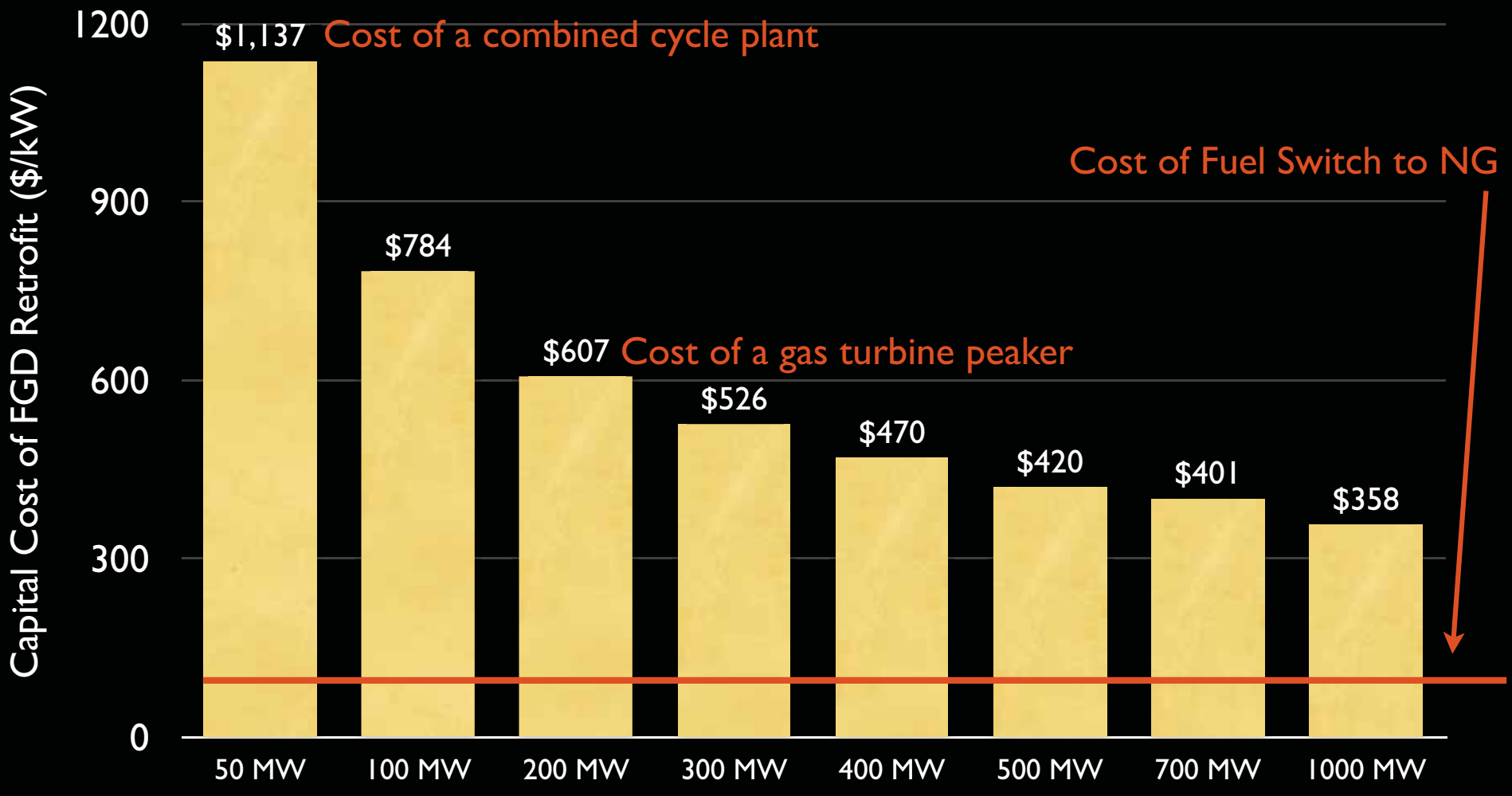
80% are less than 200 MW

50% are less than 50 MW

40% run less than 50% of the time

Source: Bernstein Report, 2010

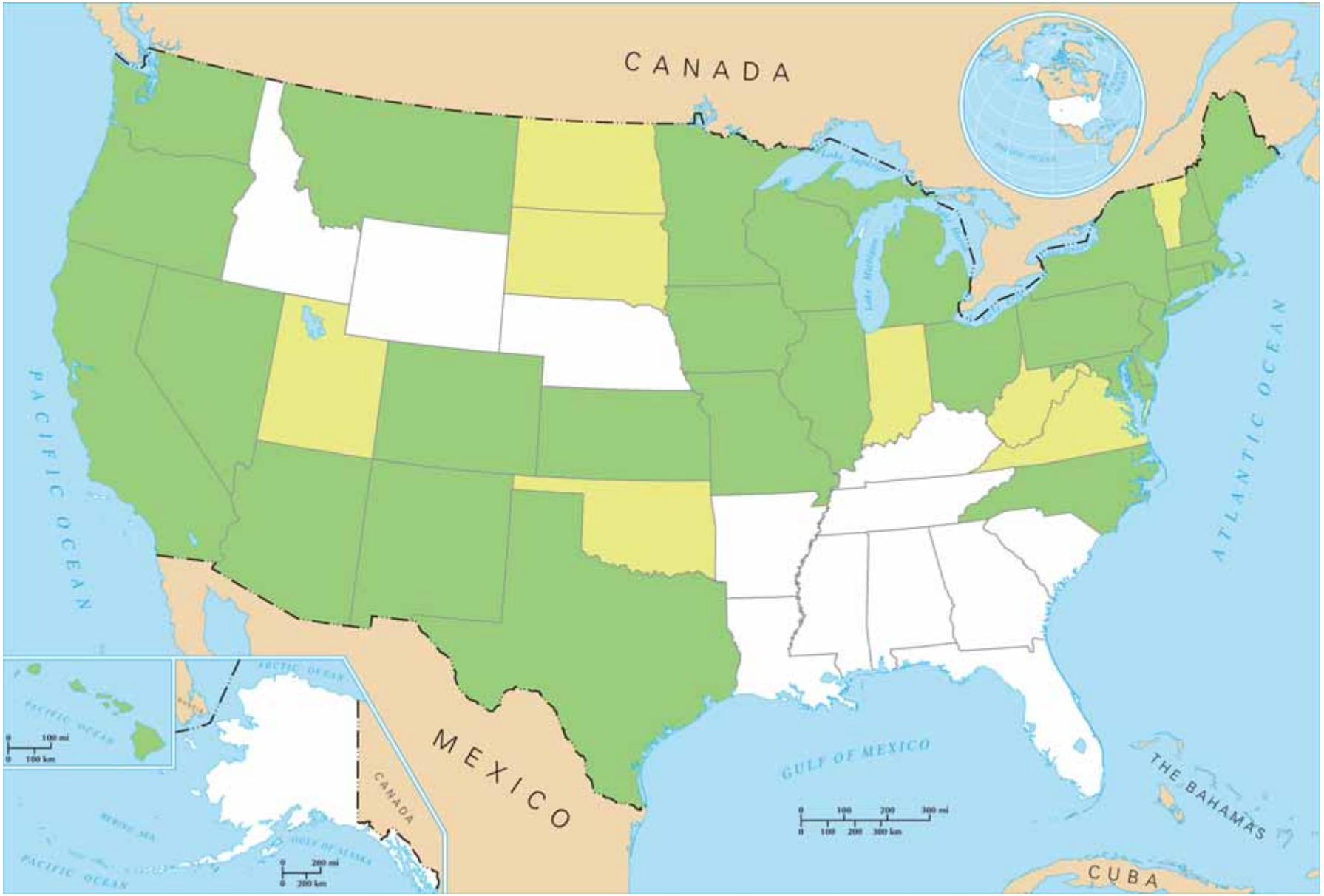
Scaleability of FGD Retrofit Costs



Source: Bernstein Report, 2010

States with Renewable Portfolio Standards

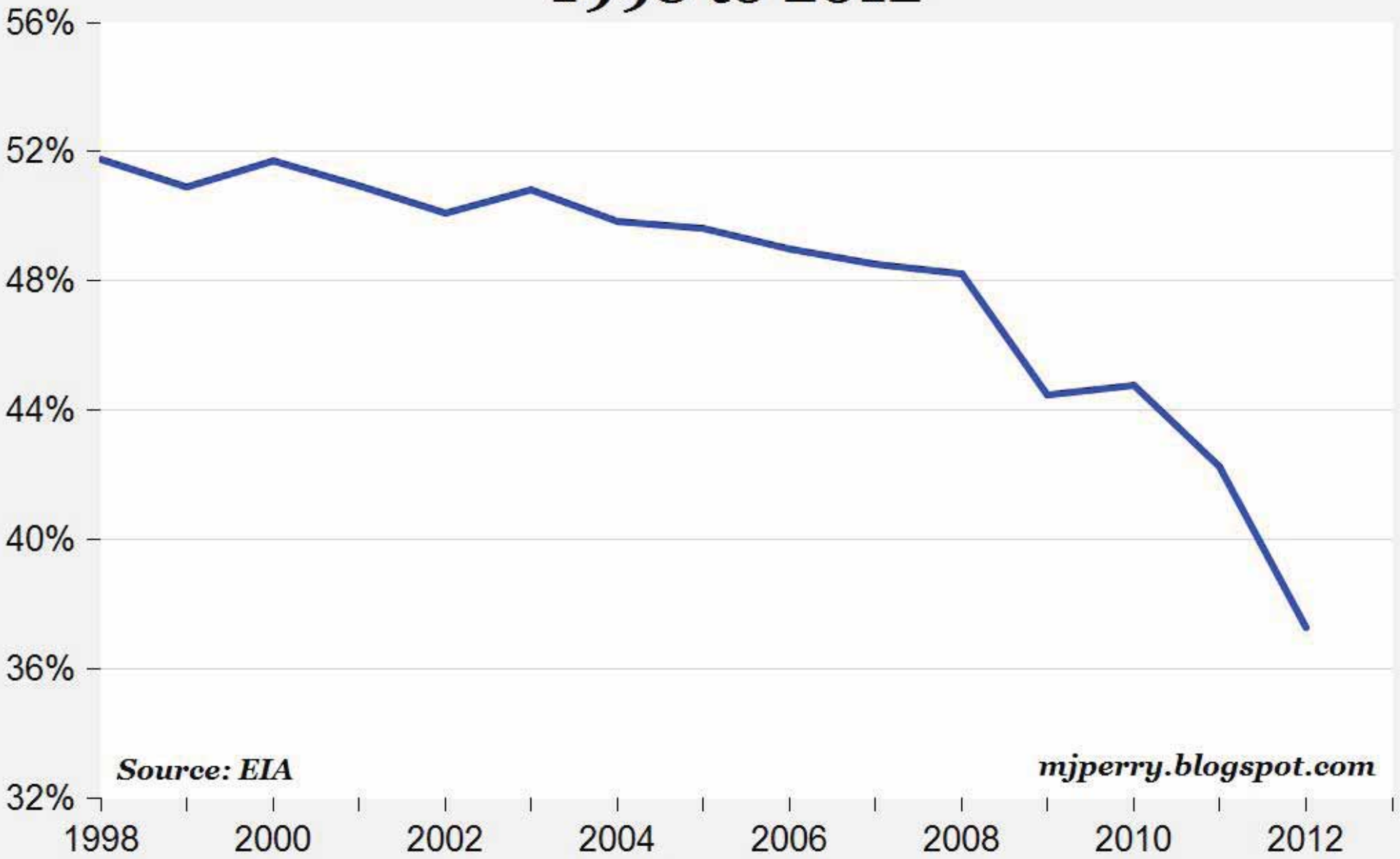
April 2012



Source: www.dsire.org


AMERICAN
GOAL
BARBEE

Coal's Share of U.S. Electricity Generation 1998 to 2012



Coal use in Europe is up...

Nuclear Plants in Germany Sit Idle as Coal use Grows by 13.5%

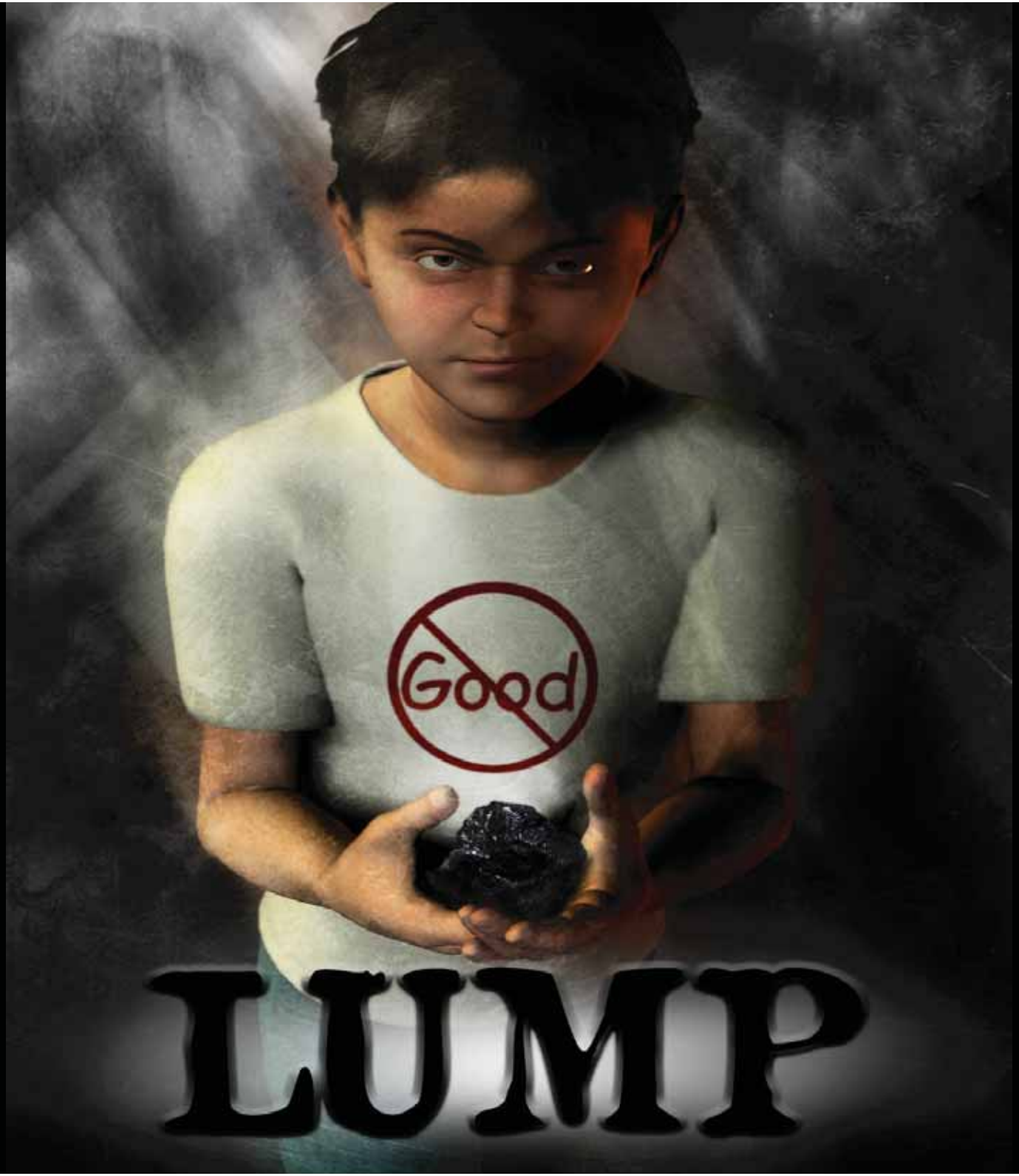
By Breakthrough Institute | Tue, 15 May 2012 23:13 | 0

0 Tweet 3 Like

Coal use will rise an estimated 13.5 percent in Germany this year, resulting in at least 14 million metric tons of additional carbon dioxide (CO2) emissions, even as the nation continues to idle two-fifths of its nuclear power fleet.

Low CO_2 credit prices causing resurgance of coal use

7€/metric ton down 60% from 2011


Good
LUMP


Lump of Coal
Dark Holiday
~ STOUT ~
Much More Than You Deserve for Xmas This Year

Who's Switching?

Dover Municipal Power Plant

18 MW Stoker

Modified for 8-15% Natural Gas Co-Firing

Complete and Operating

AEP Big Sandy

Unit 1 260 MW
Wall-fired boiler

Will rebuild as a 640 MW gas-fired boiler

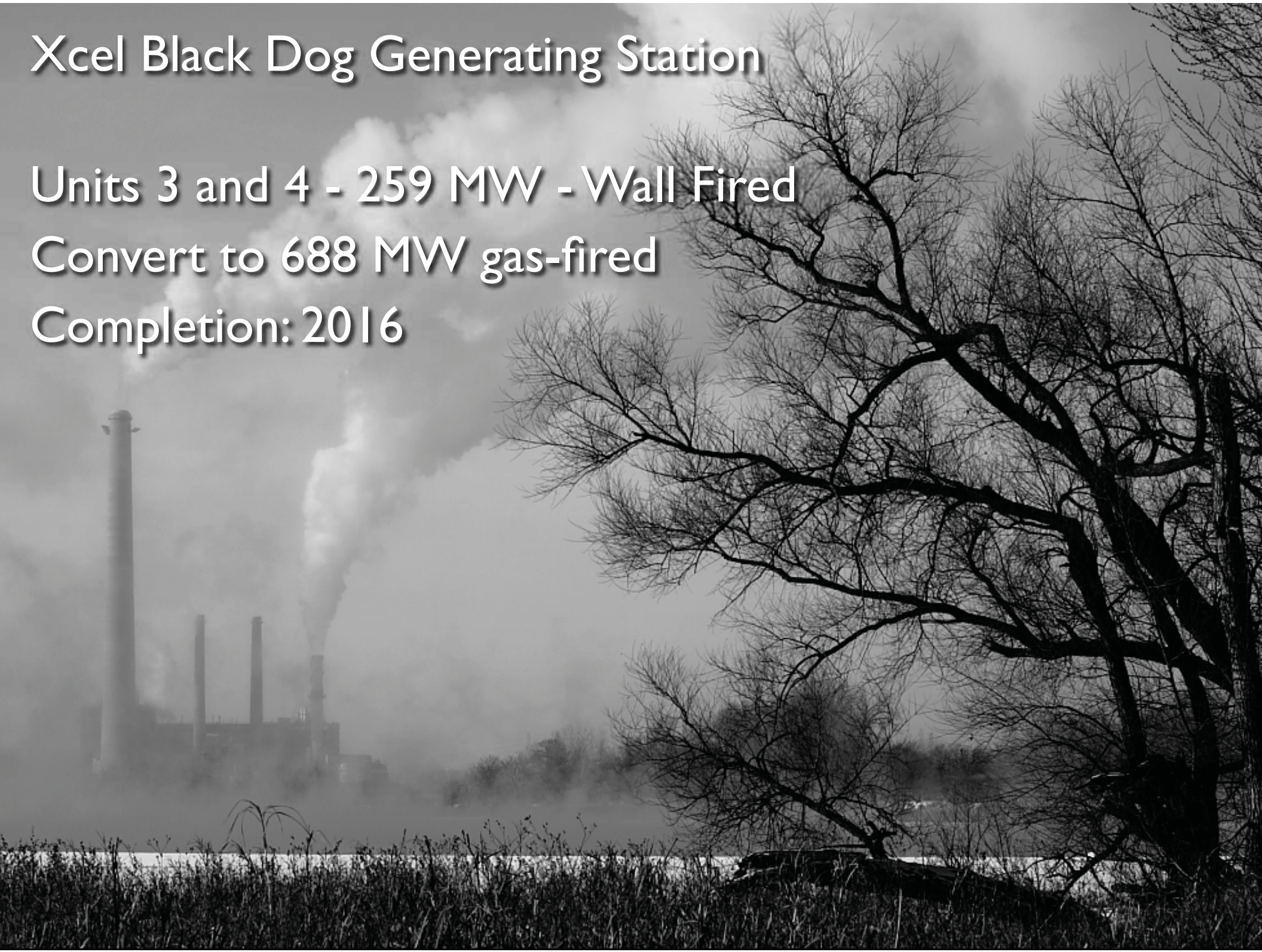
Completion: 2016

AEP Clinch River

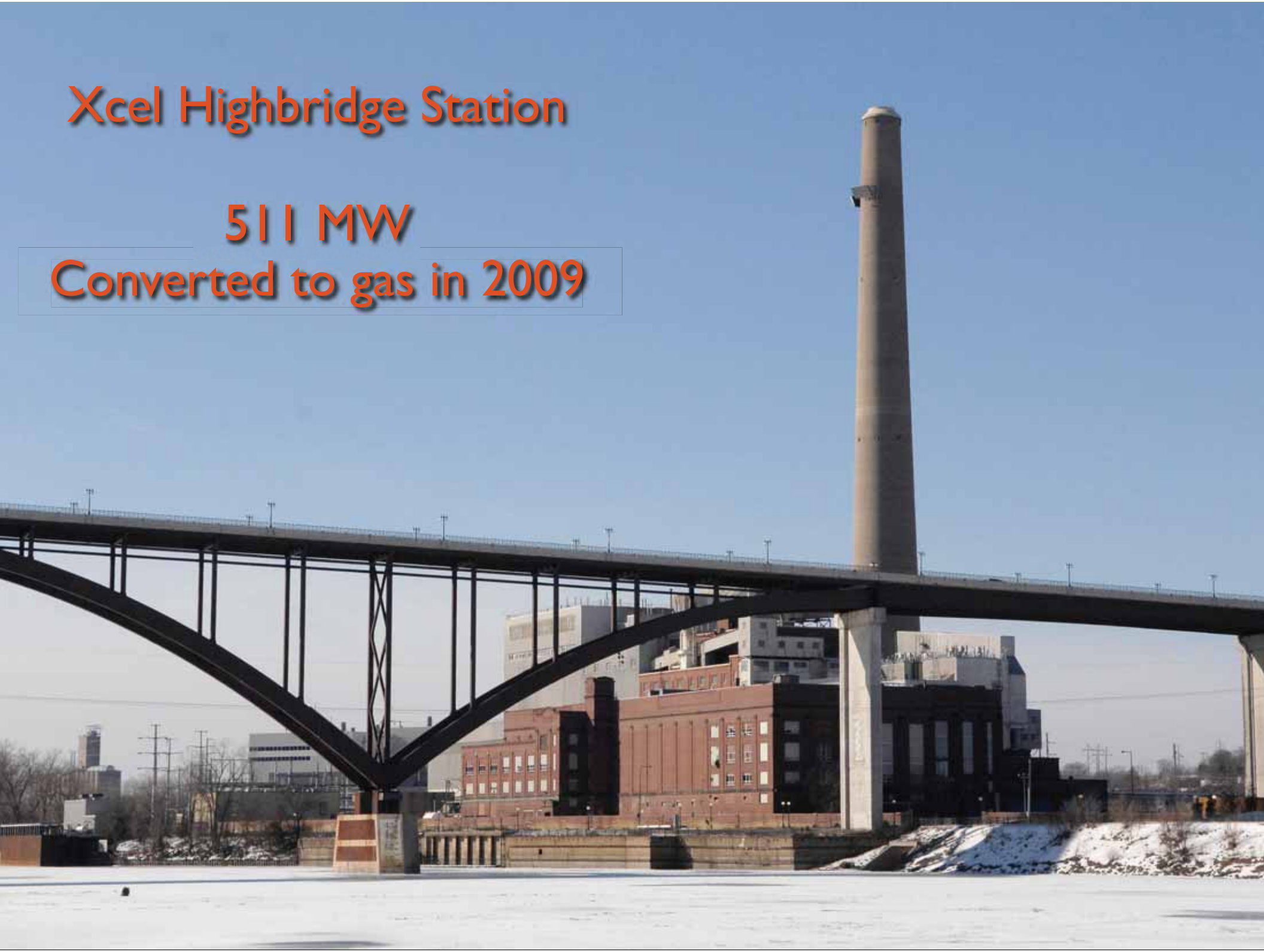
Units 1 and 2
470 MW Total
Vertical Firing

Will be refueled with
natural gas @ 422 MW

Completion: 2015


Xcel Black Dog Generating Station
Units 3 and 4 - 259 MW - Wall Fired
Convert to 688 MW gas-fired
Completion: 2016


Xcel Riverside Station
570 MW
Converted to gas in 2008


Xcel Highbridge Station
511 MW
Converted to gas in 2009

AEP
Muskingum River Plant

Unit 5
585 MW cell-fired

May be refueled with
natural gas @ 510 MW

Completion: 2014

Penn State
West Campus Steam Plant

Units 2 and 3

Co-gen plant

4 coal-fired stoker boilers

110,000 pph steam each

Completion: 2014

US Capitol Power Plant

In 2009 Congress directed the plant to switch from coal to natural gas

After some burner redesign, the plant now burns 88% NG

Planning on adding combined cycle unit

Units 7, 8, 9
190 MW Total
Wall-fired

Completed transition to 100 MW natural gas in 2010

Unclear as to changes made

Madison Gas and Electric
Blount Street Station

Units 1-4
280 MW Total
Wall-fired

Announced in 2011

Limited details available

We Energies Valley Station

South Carolina Electric and Gas

Converting 5 Units
Retiring 6 Units

Converting

Urquhart Unit 3 (2012)
Canadys Units 2 & 3 (2015)
McMeekin Units 1 & 2 (2015)

Urquhart Units 1 and 2 converted in 2001

2 Units
306 MW Total

First unit online
with NG in 2014

Ontario Power
Thunder Bay Generating Station

Taylorville Energy Center

Taylorville Energy Center (TEC) is a proposed 716-megawatt (gross), 602-MW (net) coal-fed power plant using an advanced technology called *Integrated Gasification Combined-Cycle* (IGCC) with *Carbon Capture and Storage* (CCS) to make it among the cleanest power plants in the world.

TENASKA®


Permitting Issues

GHG NSPS Proposal

"Although modified sources would not be subject to the 1,000 lb CO_2/MWh standard for new sources, the EPA anticipates that modified sources would become subject to the requirements the EPA would promulgate at the appropriate time, for existing sources under 111(d)" (p. 153).

N_2O From SNCR and Urea

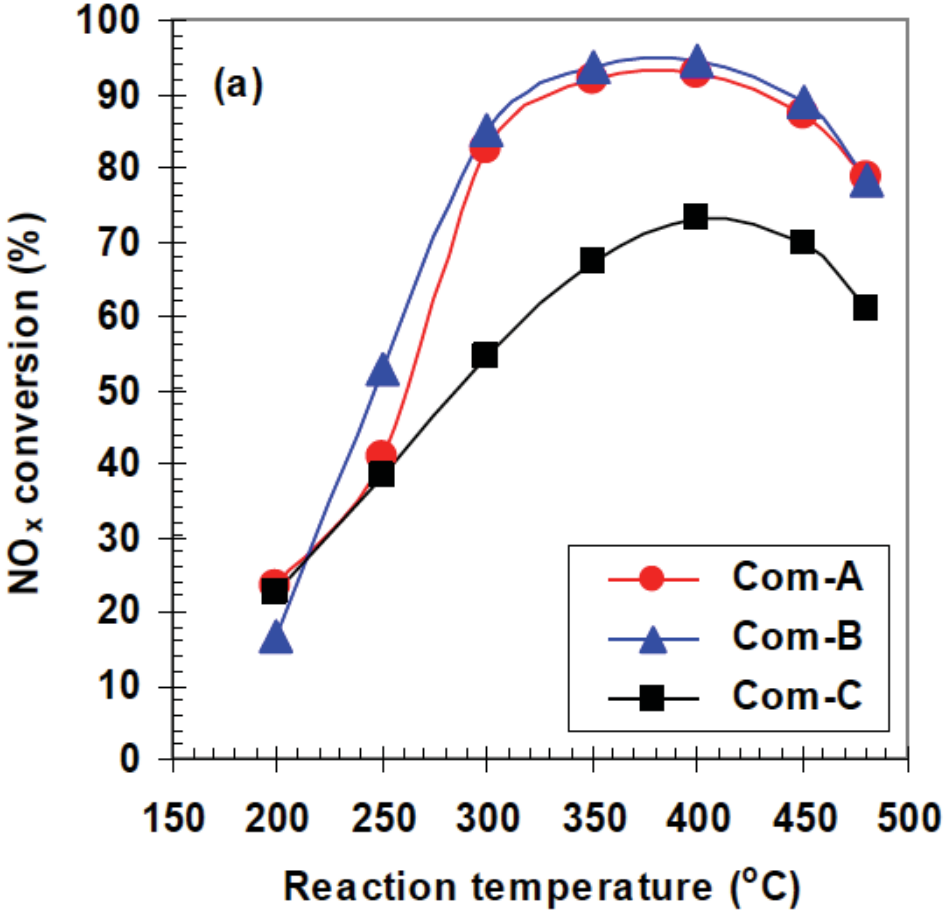
N_2O GWP = 310

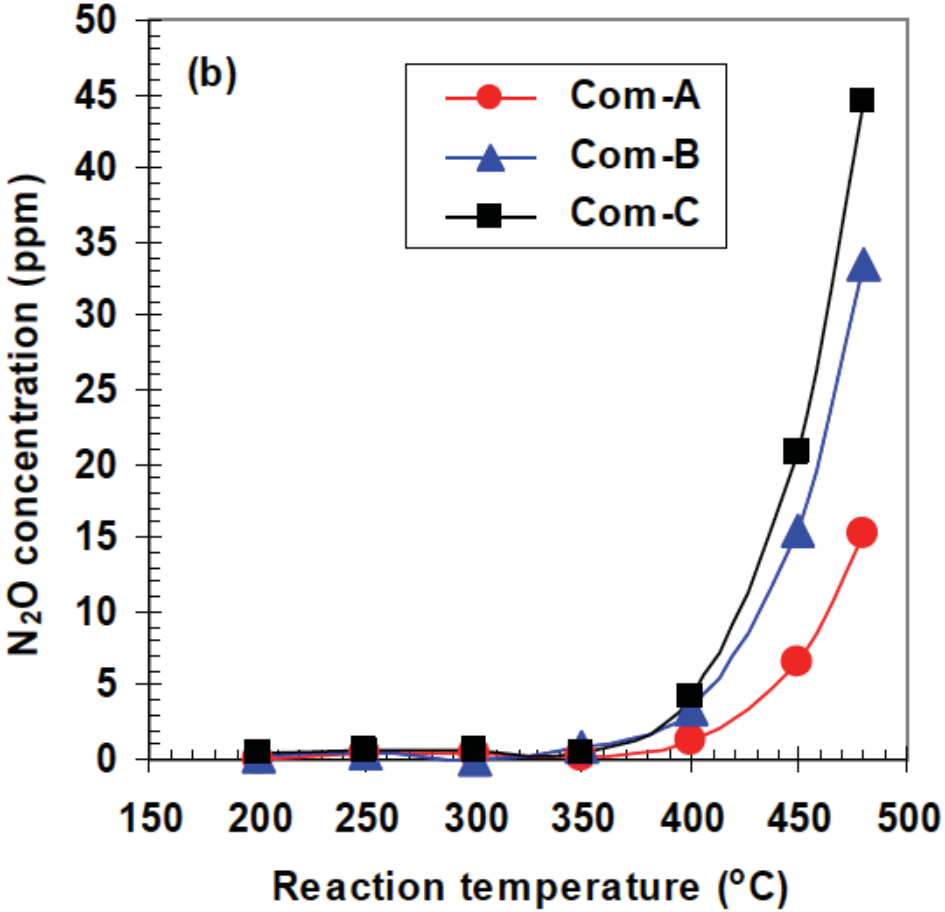
About 9% of NO is converted to N_2O

Source: Yang, W., et. al. "Nitrous oxide formation and emission in selective non-catalytic reduction process", FRONTIERS OF ENERGY AND POWER ENGINEERING IN CHINA, Volume 1, Number 2 (2007)

N_2O From SCR Catalyst

N_2O GWP = 310





Source: Lee, Y.H, et. al. "The Formation of N_2O from NH3 -SCR Reaction over Commercial V2 O5 /TiO2 -Based Catalysts", North American Catalysis Society Meeting, 2009

"This is the battleground..."

"The reason we care desperately and have adopted a policy of leaving no coal plant unopposed is because each of them is such a massive new source of air pollution and a particularly large source of global warming air pollution."

Bruce Nilles, Sierra Club
Kansas City Star, April 11, 2006


beyond oil.


BEYOND
COAL


BEYOND
NATURAL GAS

CleanAir®

sevans@cleanair.com