

COAL to SNG via Gasification: Efficiency, Environmental and Economic Benefits

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by

Dale Simbeck
SFA Pacific, Inc.

444 Castro Street, Suite 702
Mountain View, California 94041, USA
web home page: www.sfapacific.com

phone: 1-650-969-8876
fax: 1-650-969-1317
e-mail: info@sfapacific.com

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Presentation Overview – Why SNG?

Strategic flexibility for uncertain NG supply/price:
historic cyclic prices plus unclear future prices of NG

- U.S. NG industry will not “put their money where their mouth is” with fixed-price, long-term NG contracts for baseload power
- The only long-term NG contracts are for LNG tied to world crude energy price parity (if \$100/bbl COE = \$17/MM Btu NG)

Advantages for replacing old existing coal power plants via (S)NGCC repowering & reducing CO₂ emission at optimum SNG site via CO₂ capture & storage (CCS)

- SNG developers likely need fixed-price, long-term NG contacts
- Low added costs of CCS at SNG site as always “CO₂ capture equipped & storage ready”, regardless of CO₂ mitigation issue
- SNG fired NGCC has many advantages over H₂ fired IGCC

Misinformation on U.S. Shale Gas

Misinformation by the U.S. tight shale gas “hypers”:

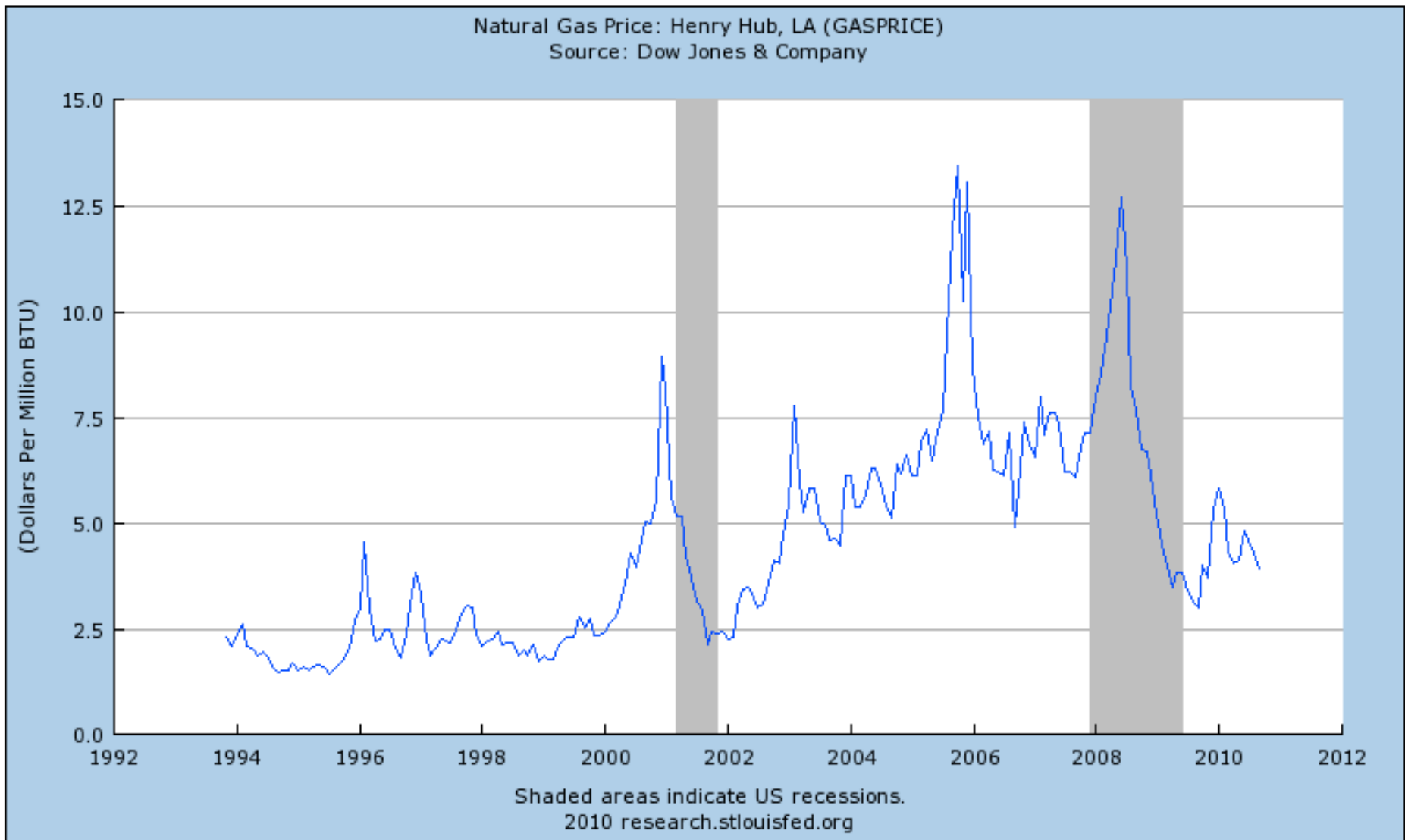
- Purposely confusing gas “resources” with much smaller gas “reserves” & reserves-to-production (R/P) from low P baseline
- Suggesting there could be enough U.S. NG to replace all U.S. coal power gen and/or the U.S. becomes a LNG exporter

Why: NG prices & sales are currently way down due to:

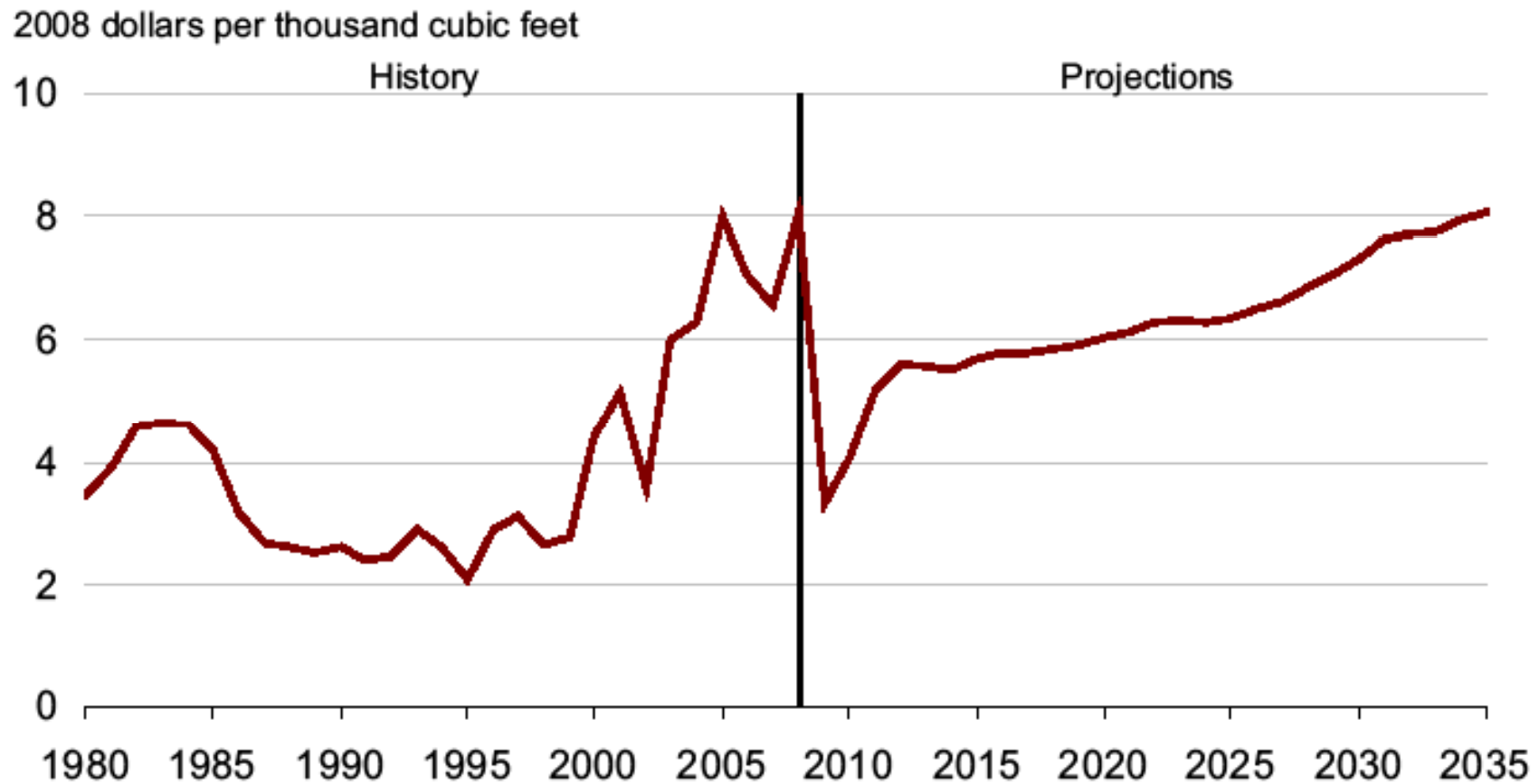
- Big drop in industrial NG demand with this severe recession
- Increased supplies of tight shale gas - developed back when NG prices & future price outlook were much higher than today

Nevertheless, as analyzed in the *2010 SFA Quarterly Report*, deregulation of the U.S. NG industry increased innovation & economic motivation producing “game changers” in unconventional NG developments

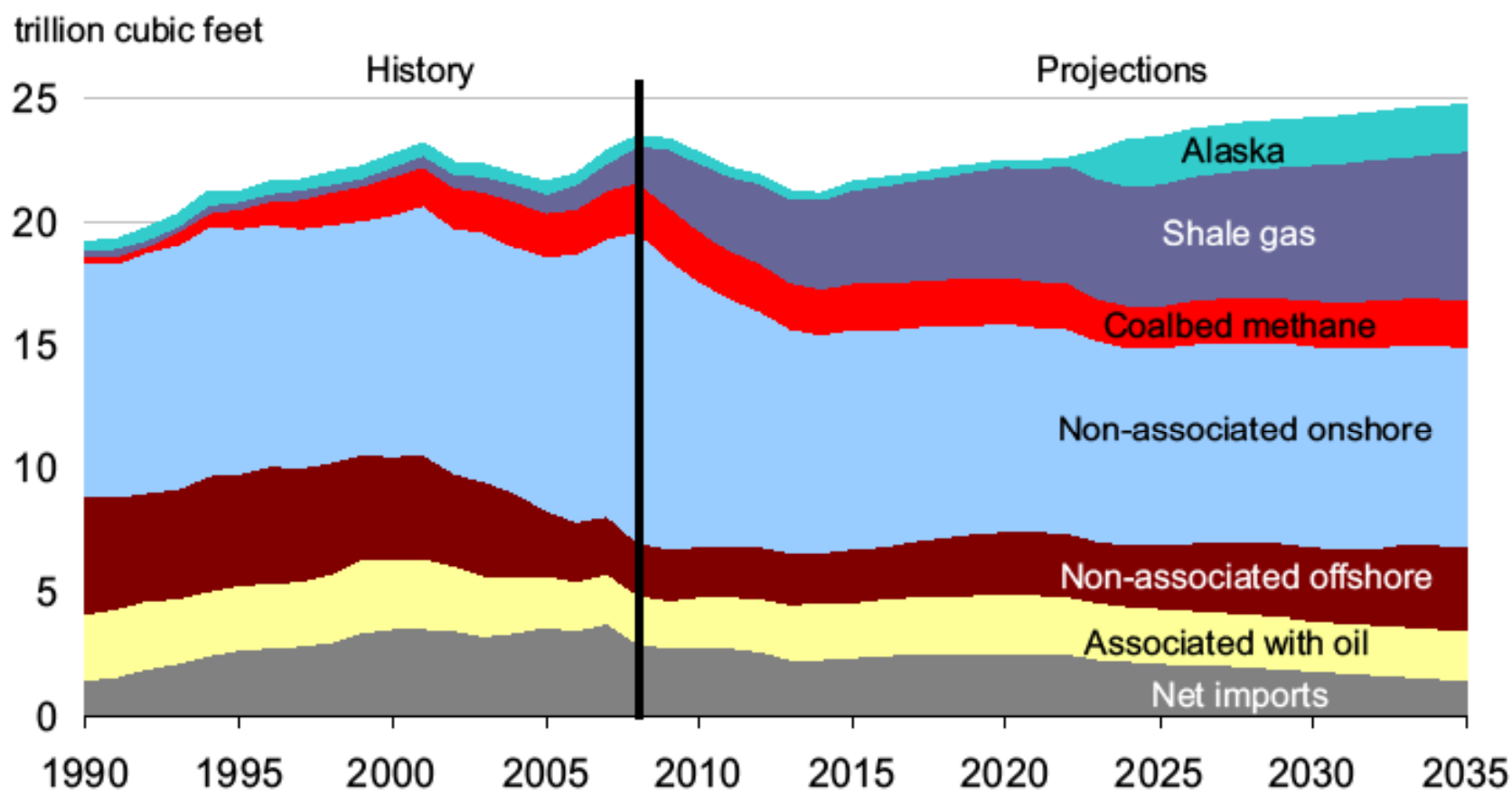
U.S. Cycle NG Prices: UP when high oil prices (+ bad hurricanes) but DOWN when recessions reduce demand



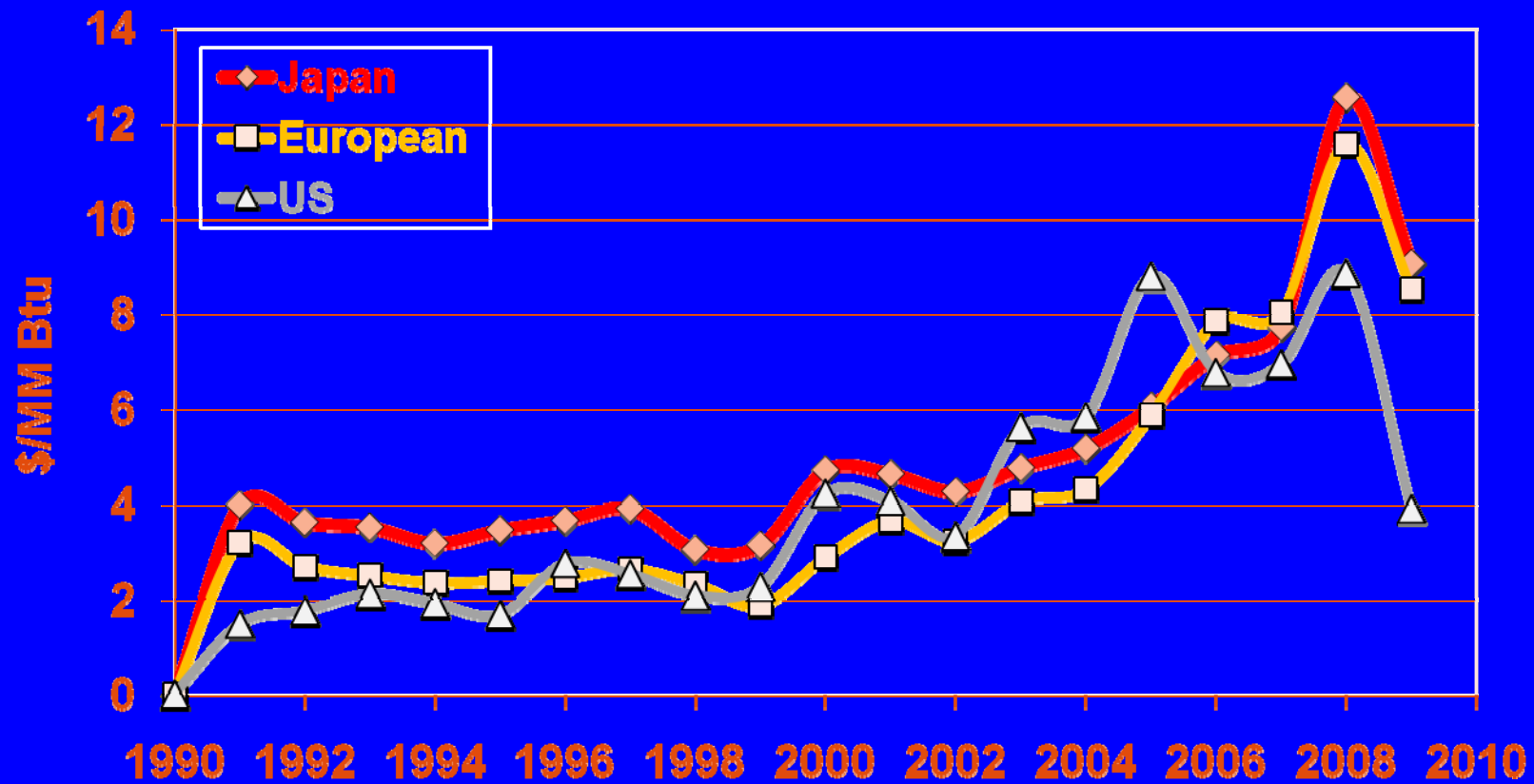
Natural gas wellhead price is projected to rise from low levels experienced during 2008-2009 recession



Shale gas and Alaska production offset declines in other supply to meet consumption growth and reduce imports



Average combined NG & LNG Prices Into Main Pipeline "Hubs" (delivered LNG)



Source: 2010 SFA Quarterly Report with data from the BP Statistical Review of World Energy 2010

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Concerns of High LNG Prices in the Future

Ministers from the Gas Exporting Countries Forum (GECF), faced with a faltering gas market, pledged unanimously to work towards achieving gas price parity with crude oil during their 2010 meeting

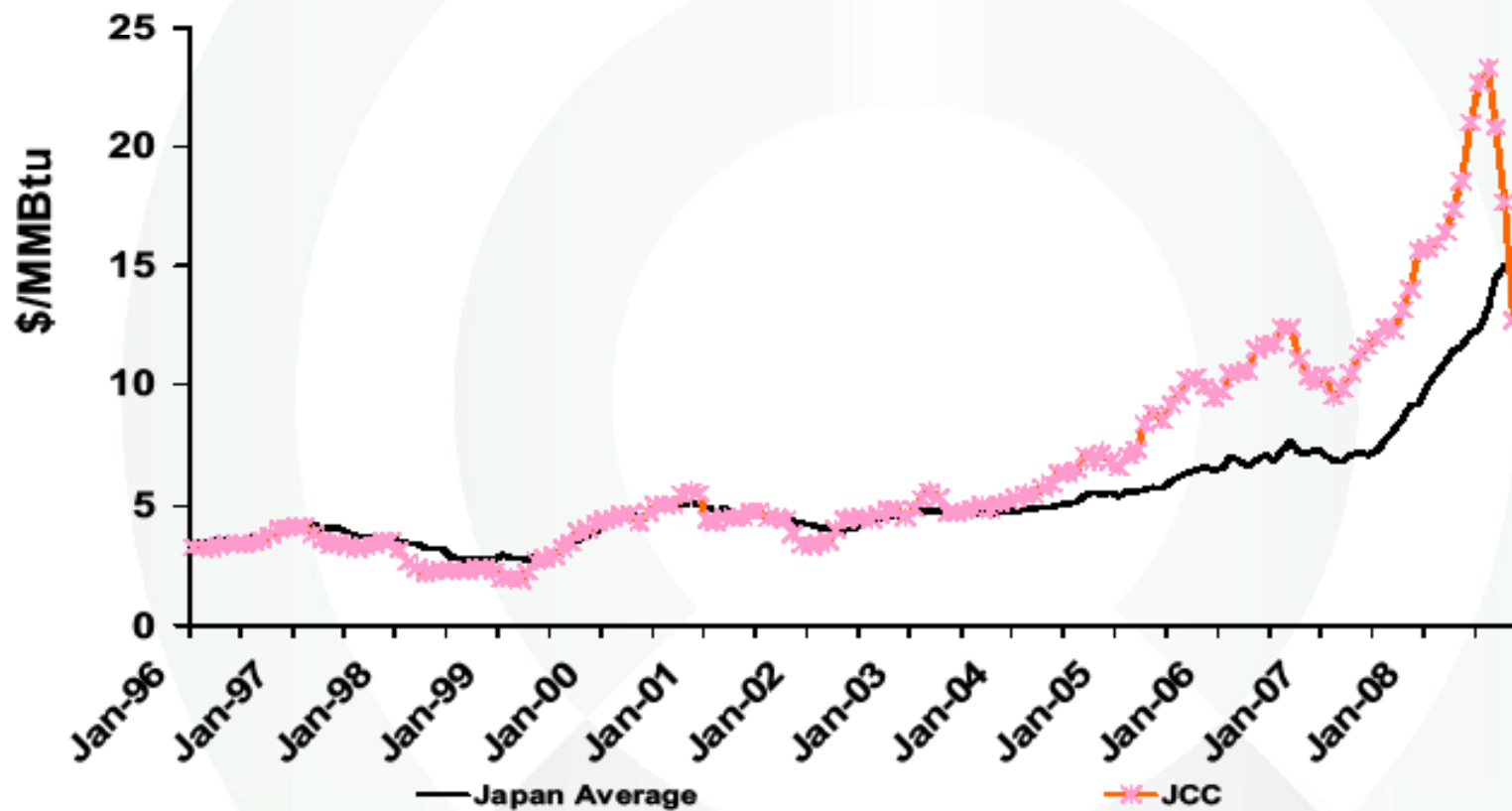
Recent Japanese and Korean LNG contracts are at world crude oil price energy parity or “Btu” equivalent

- Recent \$75/bbl world crude oil = \$13/million Btu LNG
- Future \$150/bbl world crude oil = \$26/million Btu LNG

SNG from low rank Asian coals has strategic advantages as a maximum NG “backstop” price to protect from outrageous LNG prices when world oil prices increase

- As SNG cost is mostly capital charges, once paid-off - cheap

Japanese LNG and JCC Prices January 1996- November 2008



Andy Flower and David Ledesma
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Power Generators Will Be Forced to Meet a Disproportionate Share of Any CO₂ Reductions

This was the key conclusion of our original 2001 CO₂ Mitigation Private Multiclient analysis that is currently being updated

CO₂ emissions from mobile vehicles are more challenging to reduce than large point sources of stationary big industrials

Power plants cannot move to China or India, as other CO₂ intensive industries in OECD nations are forced to do, if high CO₂ taxes

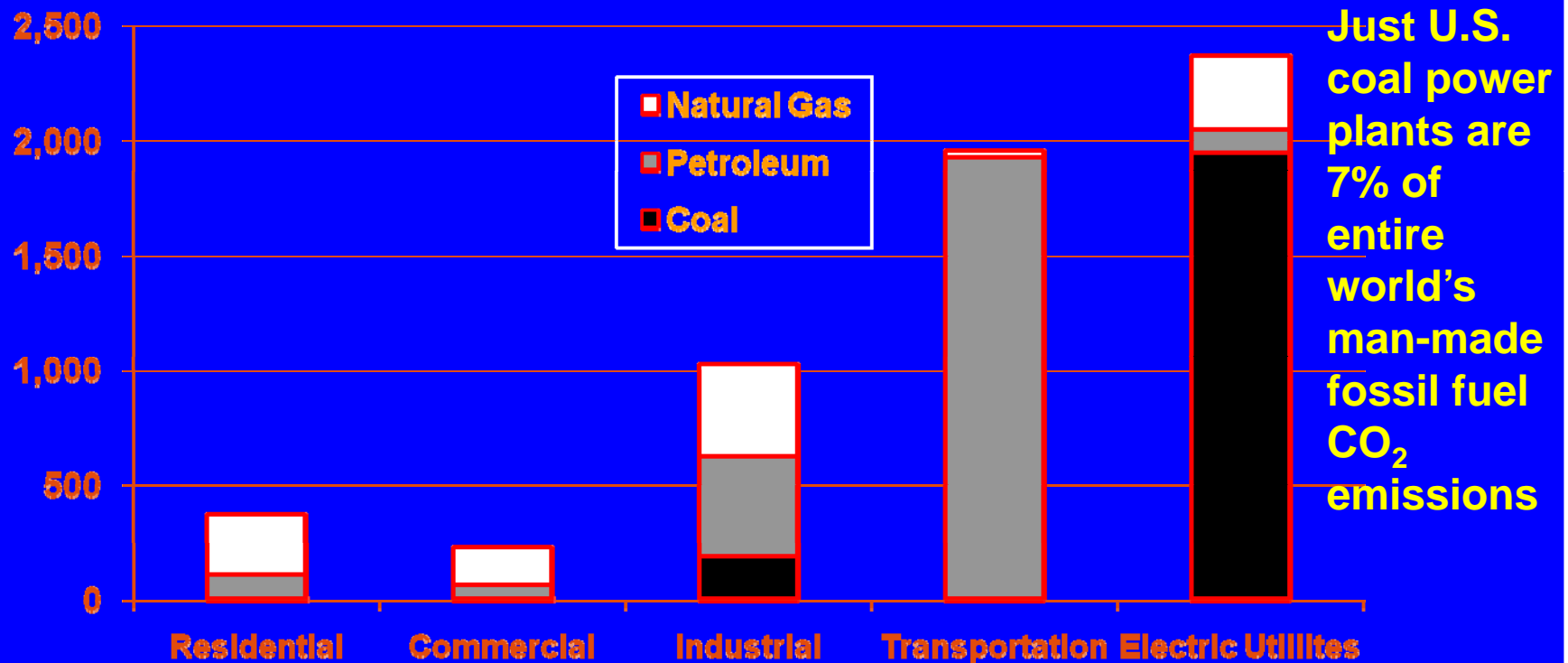
Big CO₂ reduction potential from coal-based power generation

- Reduce coal CO₂ emissions via conservation & efficiency
- Replace coal with **NG**, nuclear, biomass and wind/solar
- **CO₂ capture & storage due to the large CO₂ point sources & potential to co-process waste biomass for even bigger reductions**

U.S. CO₂ Emissions By Sector & Fuel

About 6 Gt/yr of 30 Gt/yr world fossil fuel CO₂ in 2007

Millions of metric tons per year CO₂ (divide by 3.67 for carbon equiv.)



Just U.S. coal power plants are 7% of entire world's man-made fossil fuel CO₂ emissions

Source: SFA Pacific plot from U.S. DOE/EIA-0383 February 2007 data

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Status of U.S. Coal Power Generation

**310 GW coal capacity makes ~50% of total GWhr/yr while
310 GW of NG-CC & GT makes ~20% of total GWhr/yr**

Latest 2010 U.S. EIA AEO projections for 2010 to 2035

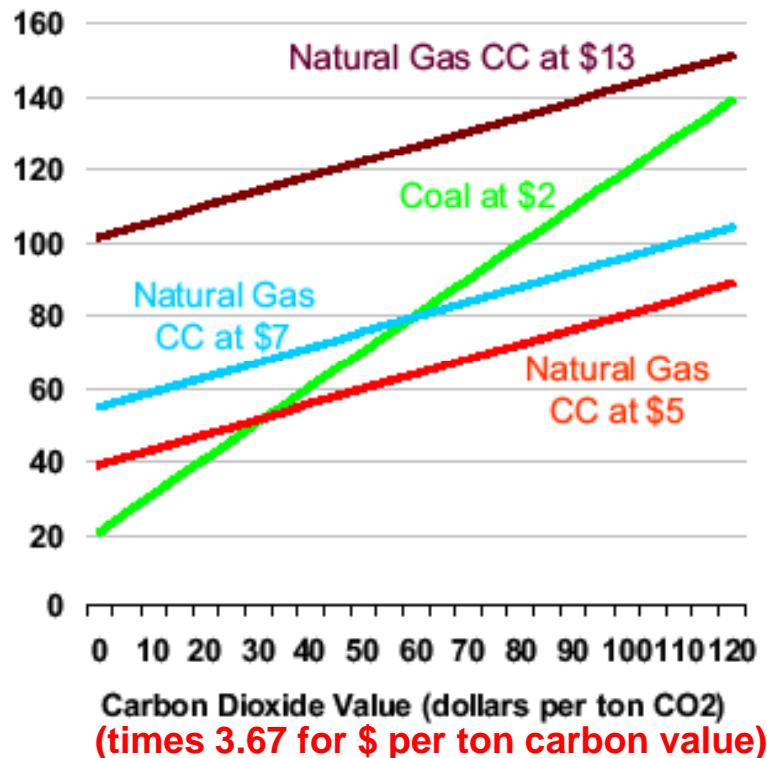
- Only 6 GW old coal retirements and just 26 GW of new coal capacity or just 8% addition new coal capacity by 2035
- **However, 18% increase in total coal-based GWhr/yr by 2035 thus mostly for running the old coal plants more**

**U.S. coal fleet: old, inefficient but becoming very clean
via many retrofit FGD & SCR due to the CAIR/CAAA**

- **Average age almost 40 years, only 33.7% efficiency and going down as more retrofit FGD & SCR emission controls are added**
- **Mostly paid-off (<10% of total coal capacity is <20 years old) thus total power cost of these coal power plants is very low + marginal load dispatch power costs lower from coal than NG**

Climate policy impact on operating costs: OLD vs. OLD

Fuel Cost for Existing Coal and Combined Cycle Natural Gas Units with a Value Placed on Carbon Dioxide Emissions
2008 dollars per megawatt-hour

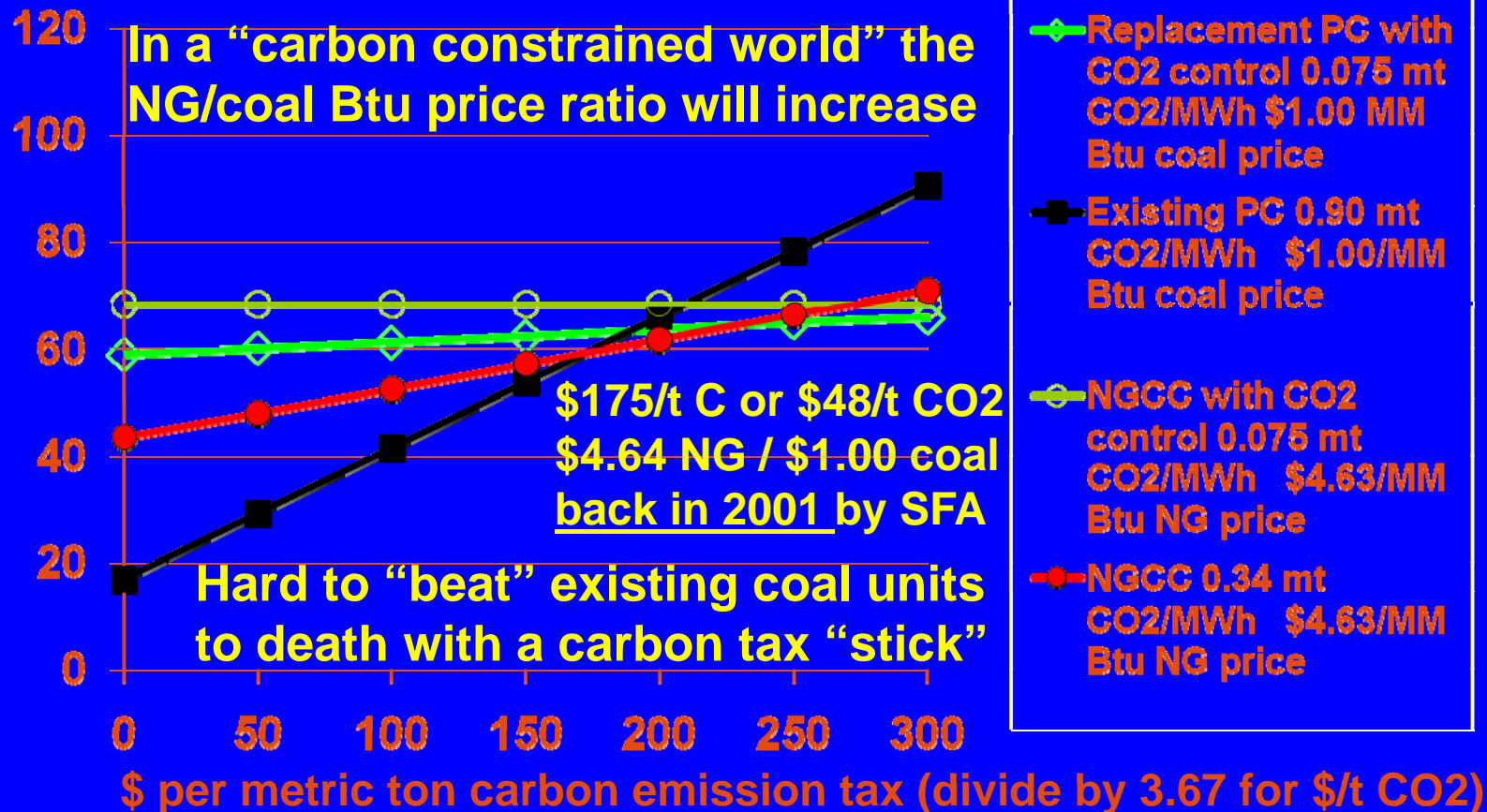


- Climate policies affect the operating costs of both coal-fired and natural-gas-fired power plants
- OLD vs. OLD: The “crossover point” for least-cost dispatch of coal and natural gas capacity depends on both fuel prices and the carbon value. As natural gas prices increase, the “crossover” occurs at a higher carbon value.
- NEW (not shown) vs. OLD: Carbon values may eventually get high enough to make the capital plus operating costs of new no-carbon generation cheaper than the operating only costs of an existing generation unit. At that point, operators would retire the existing unit.



Electricity Costs for Existing Coal Power Plant Upgrades if Carbon Taxes

\$ per MWh Electric Price with capital charges for new investments



Source: SFA Pacific original 2001 CO₂ Mitigation Multiclient, now being updated

NGCC Repowering of old U.S. Coal Plants

Easy to permit, lowest capital & emissions, highest efficiency with capacity increase of 3/1 by matching the old ST size with 2 time GT capacity plus saving of old once-through cooling water

However, enormous risk of future NG supply & price as NG suppliers are unwilling to sign fixed-price, long-term NG contacts

Coal to SNG even with CCS can help resolve this major impasse

- All commercially proven technologies - can do today or when high NG prices of a carbon constrained world makes SNG w CCS competitive, SNG plants are “CO₂ capture equipped & storage ready”
- SNG added strategic flexibility of long-term, fixed price for low CO₂ gas (from coal) for uses in various locations and applications

CCS is strategic for technical, economic, energy supply & most importantly, large CO₂ reduction potential capability

- SNG from coal supplies a lower cost and more flexible CCS option

Attributes of the Proposed Tenaska Taylorsville Coal to (S)NGCC Power Plant

Advantages:

- All commercial technologies while totally avoiding the limitations & heartburn of H₂ fired GT for CCS
- Improve efficiency & lower costs with standard NG design “G” or “H” class GT from any of the GT vendors
- Low marginal load dispatch cost of NG into pipeline or coal-based electricity into grid - depending on current and futures markets plus the NG/electricity “spark spread”

Disadvantages:

- Short-term cheap NG prices favors NGCC over “new” coal plants with high capital costs & associated capital charges
- Lower efficiency & higher cost of syngas to SNG with CCS

CO₂ Capture & Storage (CCS) Attributes of Separate SNG or SNGCC over H₂-IGCC

Decouples the coal CCS site from its low C fuel end-use

- SNG CCS plant can be at optimum location for cheap coal, effective CO₂ storage (EOR) + near existing NG & CO₂ pipelines
- CCS retrofit of existing coal power plants is limited due to lack of space & nearby CO₂ storage site + permitting a CO₂ pipeline
- **Low costs CCS as SNG is truly “CO₂ capture equipped” + “CO₂ storage ready”**, regardless of the CO₂ mitigation Issue

Avoids extra costs, power & limitations of H₂-fired GT

- Avoid massive flow of air-blown IGCC or added cost & lost efficiency of HP ASU for HP N₂ to H₂-GT
- SNG in any standard GT + higher efficiency G & H class GTs
- Can sell SNG or low CO₂ electricity, based on market prices

Summary and Conclusions

LNG prices tied to world oil parity creates a potential for coal-SNG to set LNG price “backstop” or upper limit

Current U.S. “hype” of unconventional NG due to:

- Lower NG prices due to lost demand of recession while increased shale gas supply, thus want increased NG use in power gen.
- But will not put their money where their mouth is with long-term, fixed NG prices required to replace old coal plants with NGCC

SNG with CCS has several important advantages if the world ever becomes serious about CO₂ mitigation

- Decouples coal with CCS from end-use of low CO₂ SNG
- Coal to SNG developers likely need long-term, fixed-price contracts plus once capital charges are paid-off – cheap SNG
- Avoids many of the added costs & limitation of H₂ fired IGCC