After the Natural Gas Bubble:
A Critique of the Modeling and Policy Evaluation Contained in the National Petroleum Council's 2003 Natural Gas Study

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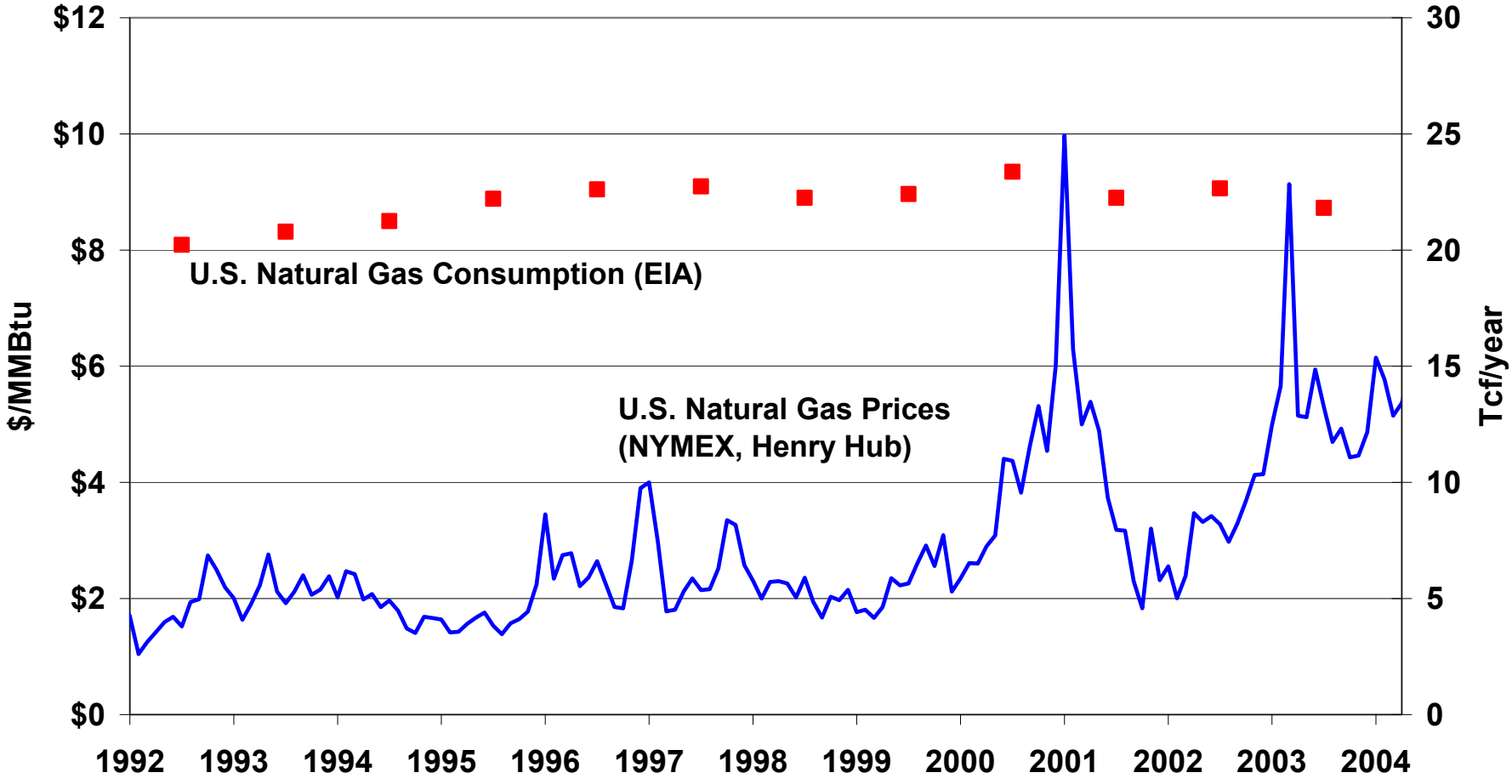
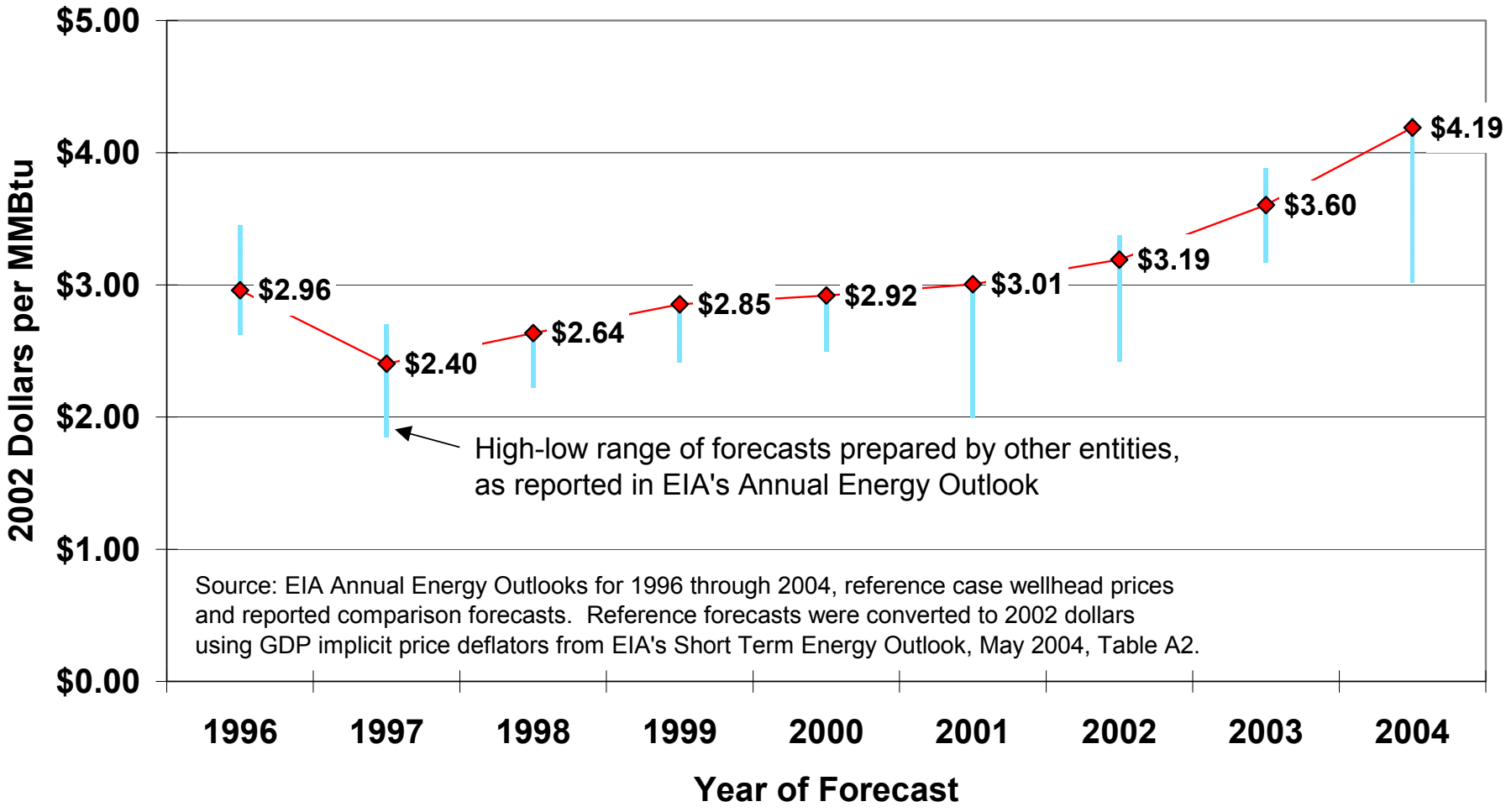
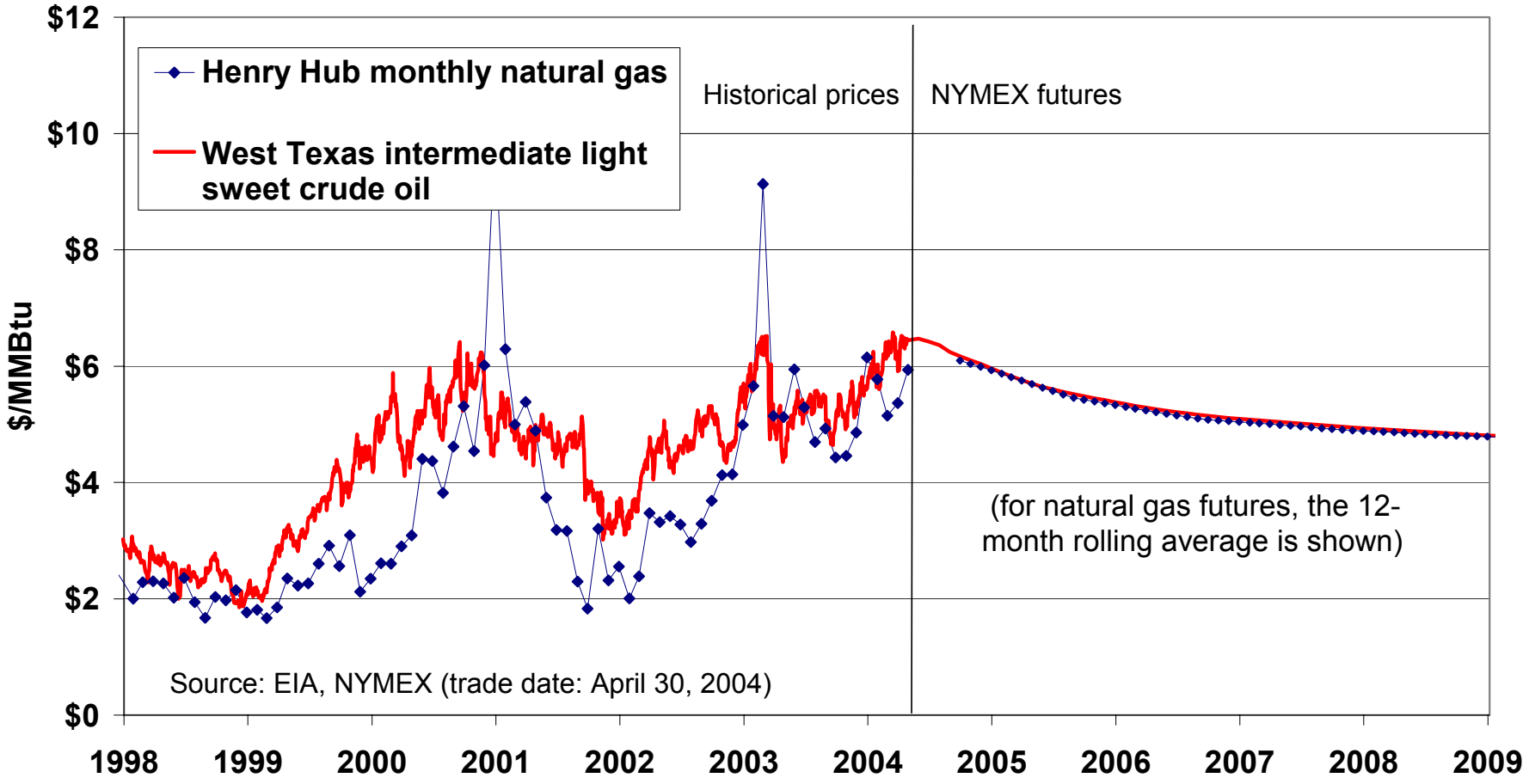
U.S. Natural Gas Demand and Prices



EIA Forecasts of U.S. Natural Gas Prices, 2015



Natural Gas and Crude Oil Prices and Futures



National Petroleum Council and its 2003 Natural Gas Study

- National Petroleum Council is a federally chartered and privately funded advisory committee, whose purpose is to represent the views of the oil and gas industry (www.npc.org)
- A substantial effort led to NPC's September 2003 report, *Balancing Natural Gas Policy: Fueling the Demands of a Growing Economy*
- The study was requested by Secretary of Energy Spencer Abraham

NPC Report: Important & Timely

- Extensively revised resource base estimates
- Indepth coverage of industrial/power demand
- Anticipates major role for LNG
- Data/information about natural gas supply, demand and infrastructure

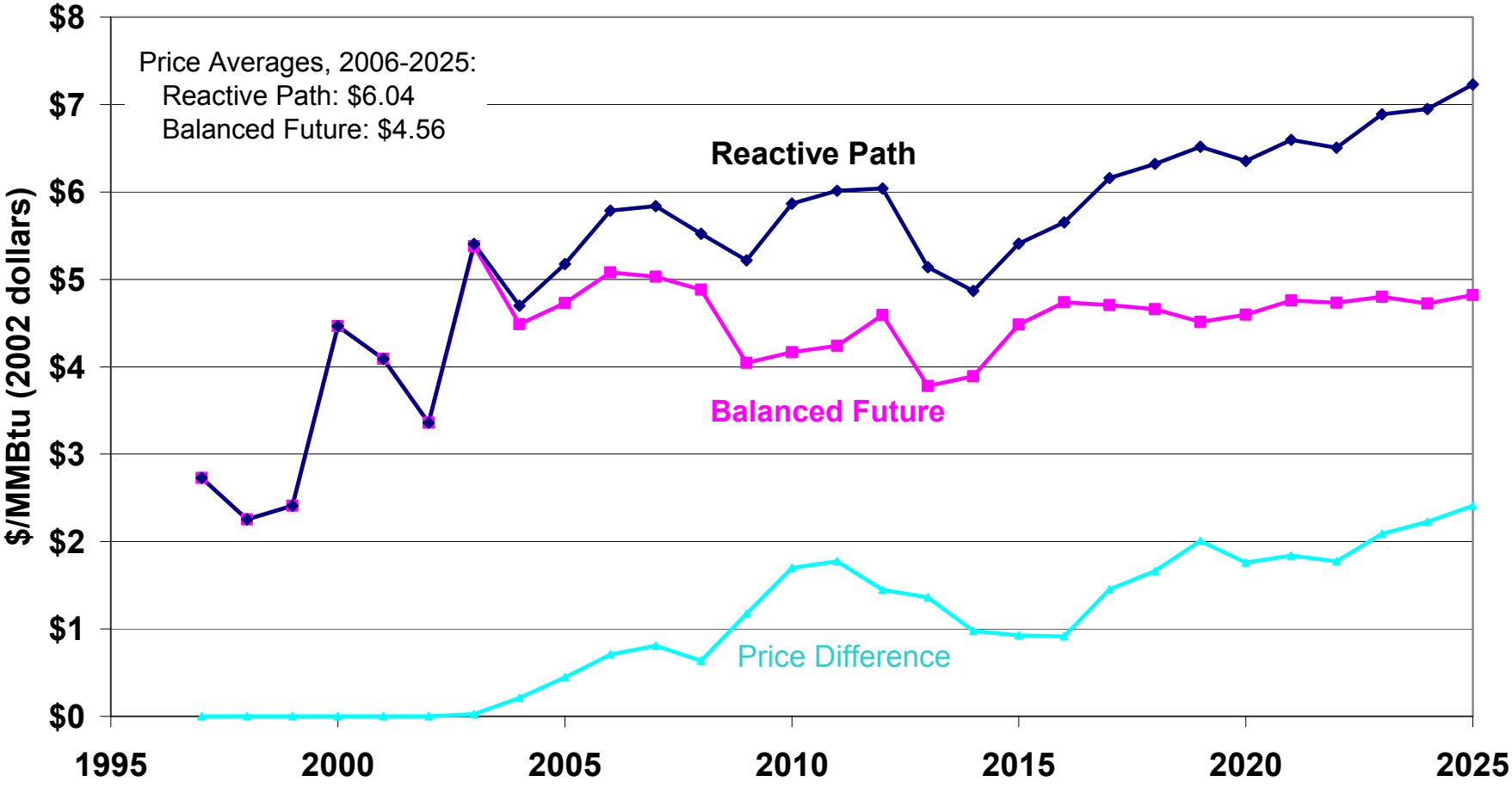
NPC Recommendations

- Supply-enhancing measures (reducing access restrictions, building Alaska pipeline, improving LNG permitting, relaxing and providing greater certainty about environmental regulations).
- Demand-reducing measures (increasing interfuel flexibility, enhancing energy efficiency, encouraging more coal, oil, and renewable use).
- Sustain and enhance infrastructure; promote efficiency of markets (outside our scope)

NPC Study's Policy Scenarios

- NPC Study used models combined with expert analysis to simulate two main policy scenarios
  - "Reactive Path" – generally assumes continuation of existing policies regarding natural gas, other fuels
  - "Balanced Future" – assumes recommended policy changes to enhance supply, reduce demand
- Other assumptions identical between the scenarios
- Models show a large price difference between the two scenarios – implies large consumer benefits result from the BF policies

Reactive Path and *Balanced Future* Scenarios



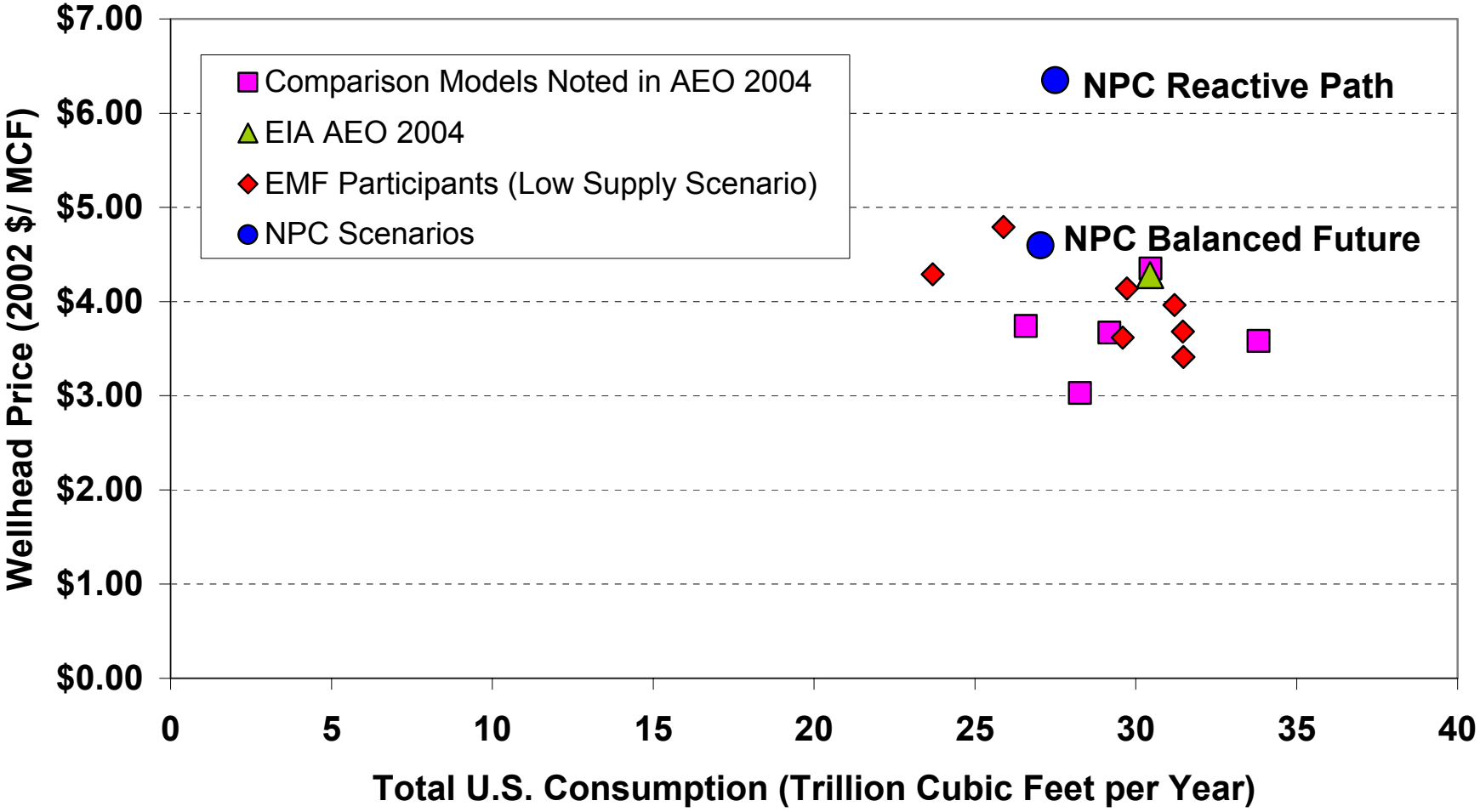
NPC Finding 11:

A balanced future that includes increased energy efficiency, immediate development of new resources, and flexibility in fuel choice could save $1 trillion in U.S. natural gas costs over the next 20 years. Public policy must support these objectives.

Why It Is Important To Get This Right

- Large anticipated benefits may justify bold and costly policies to lower gas prices and costs.
- Alaskan pipeline: Build today or delay? Taxpayer support to make it happen, or let markets decide?
- Increased access to western lands needs to be balanced with environmental considerations.
- Other recommended policies also have significant long-term impacts

Comparison of Natural Gas Outlooks, 2020



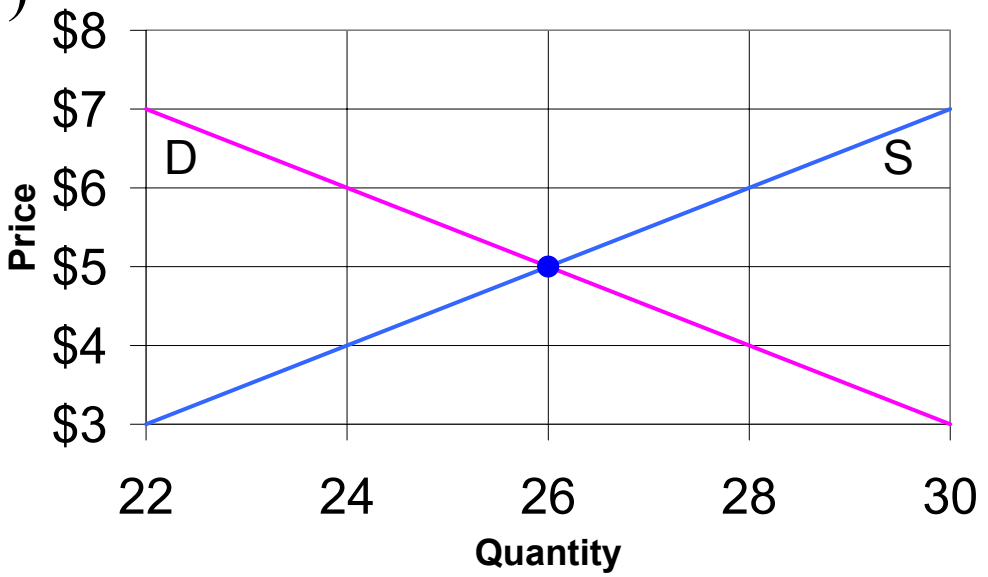
Long-Term Market Responses to Higher Prices

- Supply Responses
  - Produce resources faster
  - Develop resources considered uneconomical at lower prices
  - Develop unconventional resources, new sources (LNG)
  - Develop and apply new technologies
- Demand Responses
  - Use energy more efficiently
  - Switch to other fuels
  - Rely more on power plants that use other fuels
  - Move production overseas
  - Switch to products that use less energy

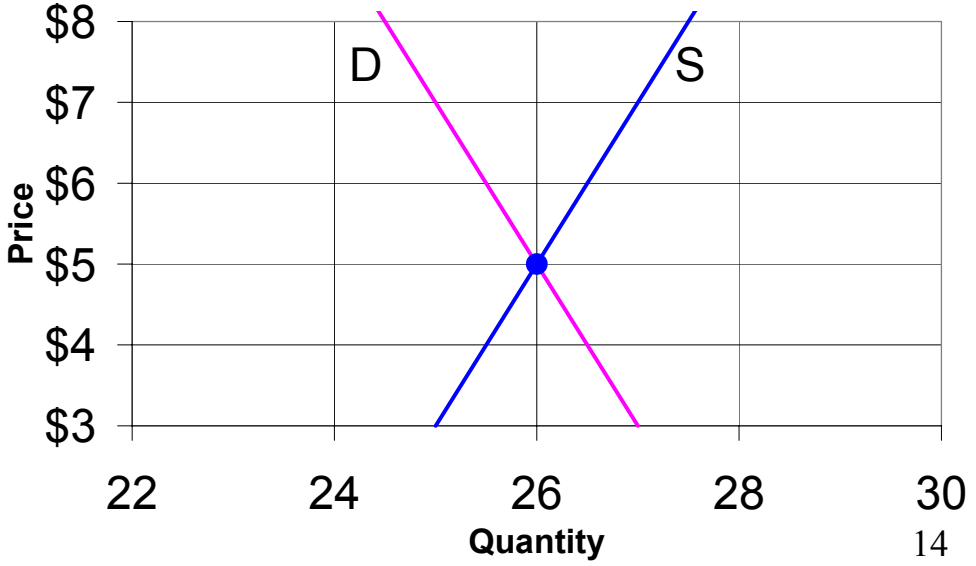
Modeling of Supply, Demand Responses Determines Price Movement (part 1)

Model 1:

In both models, the market clears with quantity=26, price=$5

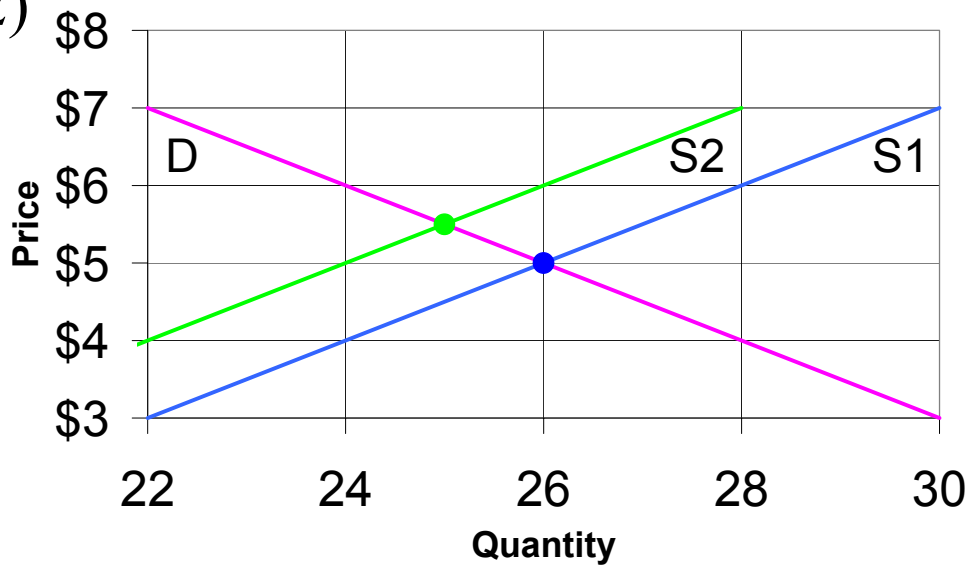


Model 2:

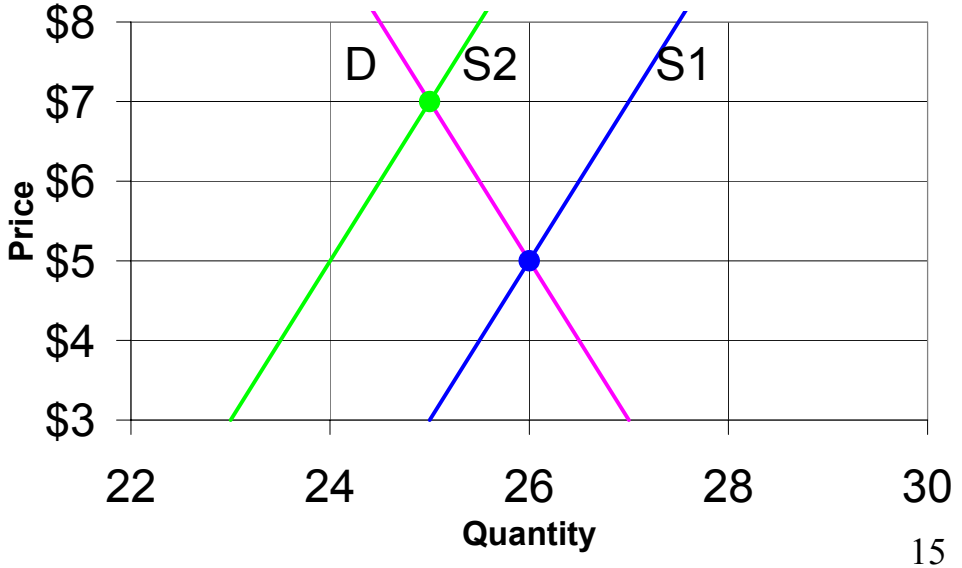


Modeling of Supply, Demand Responses Determines Price Movement (part 2)

Model 1:
If supply shifts
2 units to S2,
price rises to $5.50



Model 2:
If supply shifts
2 units to S2,
price must rise to $7



Critique of "Reactive Path" Scenario

- Various model assumptions, simplifications, and/or parameters appear to prevent or understate long-term supply and demand responses to prices.
- The scenario design assumes policy-makers at federal, state and local levels generally maintain restrictive policies that evolved during the 1990s (when gas prices averaged $2-$3) through 2025, despite $6 gas.
- As a result of muted supply/demand response, prices must remain at high levels to balance supply and demand.

Muted price response in the Reactive Path scenario:

Example: Lower-48 Production

- Higher prices should entice resource owners to produce their resources somewhat sooner (LNG is coming?)
- Sensitivity cases: A $.50/MMBtu price difference during 2011-2020 leads to some acceleration of production of Lower-48 resources:
  - By 14 days in West South Central (AR, LA, OK, TX)
  - By 23 days in Mountain (NM, UT, WY, MT, ID, NV)
- By contrast, EMF participating models show much greater response to a similar price differential:
  - By 50 days to a few hundred days, in the same regions

Muted price response in the Reactive Path scenario:

Example: LNG

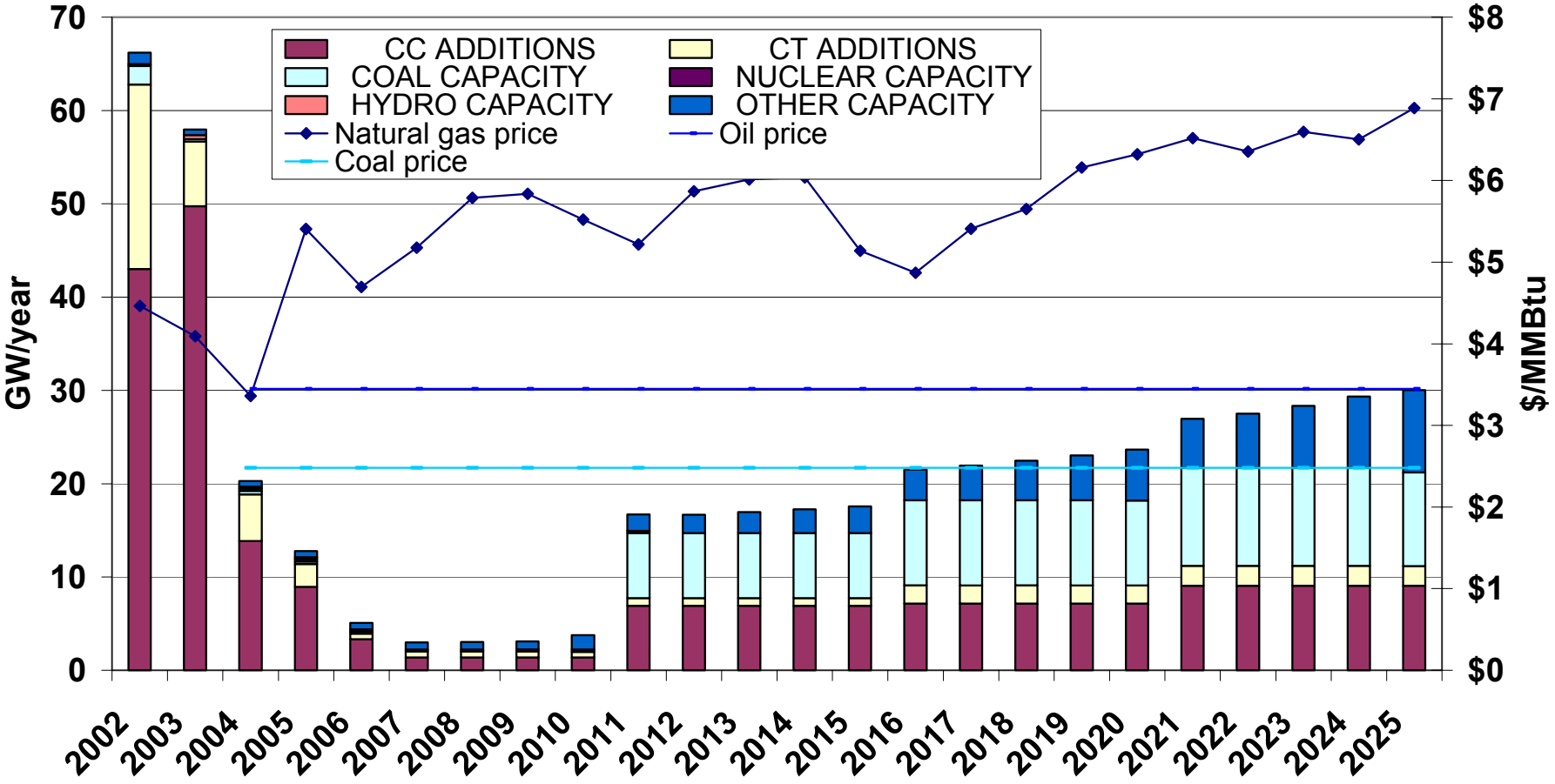
- LNG delivered cost is $2 to $4/MMBtu (NPC Report), so it is very competitive under the Reactive Path scenario ($6 average price)
- FERC reports 40 Bcf/day of existing, proposed or planned LNG receipt terminal capacity (US/CA/MX)
- But NPC's model is prevented from adding economical LNG capacity, even with a long lag; the LNG quantity was set outside the model, rising to 12.5 Bcf/day in 2025

Muted price response in the Reactive Path scenario:

Example: Gas For Power Generation

- Electric demand grows independent of electric, gas prices
- Gas-fired generation added at steady rate despite big price disadvantage v. coal, oil ($20/Bbl); no new coal until 2011
- Quantity, mix of capacity additions (gas, coal, nuclear, renewable) fixed, identical under lowest and highest price sensitivity cases ($4.44 to $8.55/MMBtu)
- Fuel switching by dual-fuel units also very restricted
- These assumptions are contradicted by market behavior in ’02-’03, when there was substantial fuel-switching

Generating Capacity Additions - Reactive Path



Muted price response in the Reactive Path scenario:

Example: Industrial Gas Demand

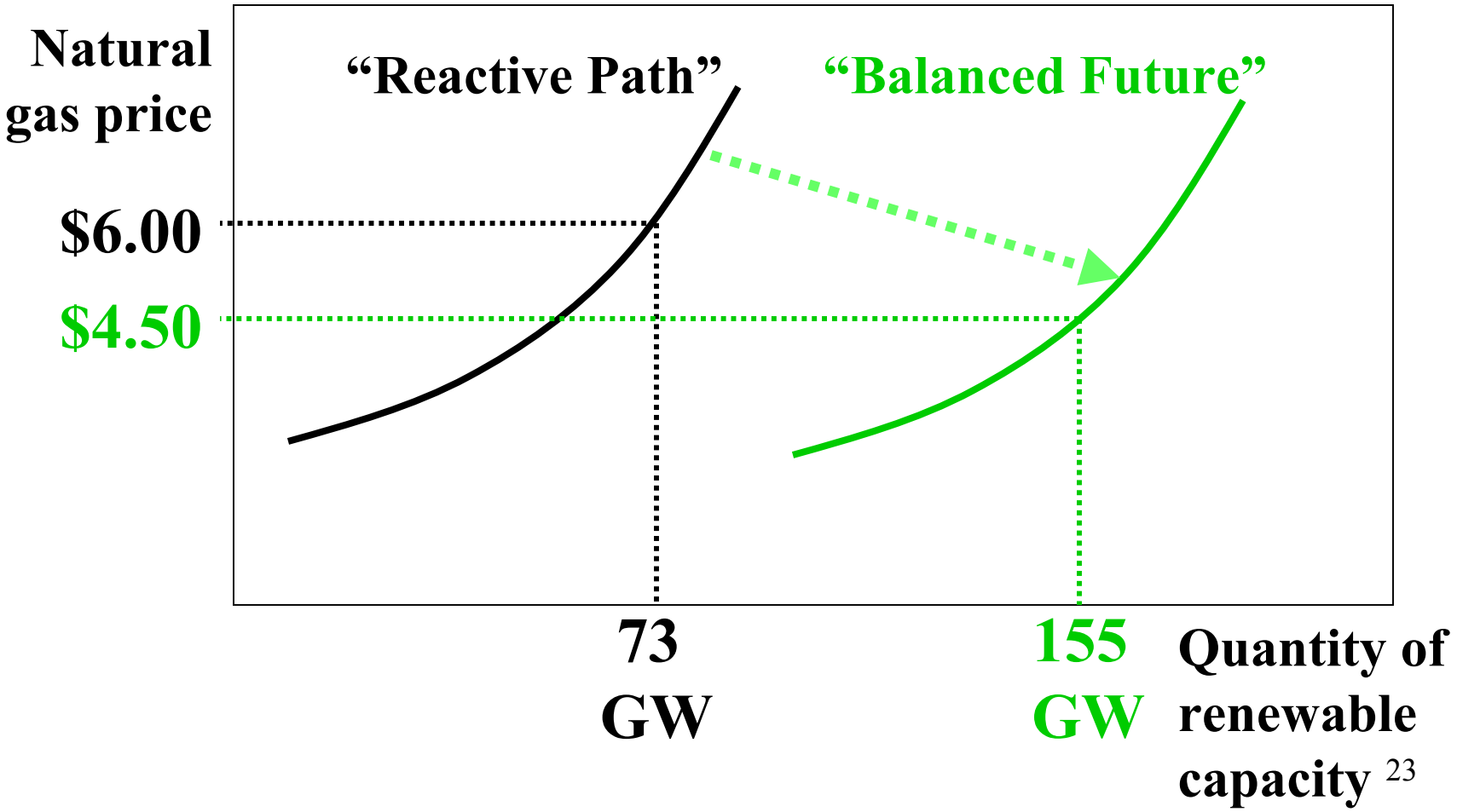
- Industrial output was set exogenously (so it does not respond to high gas prices)
- Reactive Path gas prices average 139% of #2 fuel oil prices; but fuel switching is very limited
- Industrial gas demand holds fairly steady in most sectors over 2006-2025 despite high Reactive Path gas prices

Critique of "Balanced Future" Scenario

- Relatively moderate Balanced Future prices (compared to Reactive Path) generally do not lead to lower supply or higher demand; Balanced Future policies are assumed to offset market incentives.
- Policy-makers at federal, state and local levels are assumed to adopt and maintain various aggressive policies to help expand supply and suppress demand, despite the moderate prices and reduced need (relative to Reactive Path) to do so.

Policies trump markets in the Balanced Future scenario:

Shift in Supply of Renewable Capacity



Policies trump markets in the Balanced Future scenario:

Example: LNG

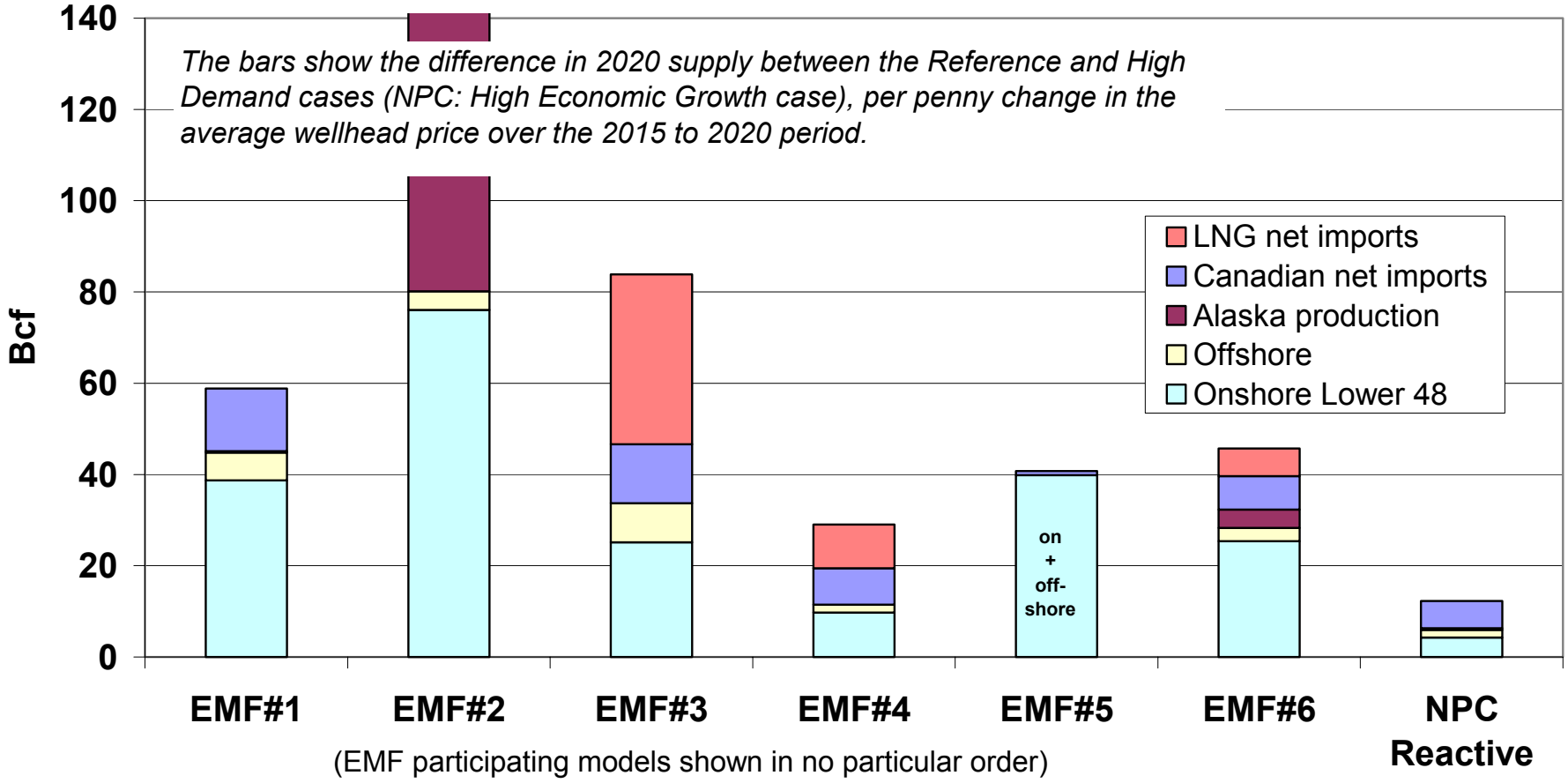
- Assumed policy difference: LNG permitting time reduced from 2 to 1 year (total time to permit, build and ramp to full operation reduced from 8 to 7 years)
- Assumed impact of policy: 15.0 Bcf/day by 2025 compared to Reactive Path 12.5 Bcf/day
- One year reduction in permitting time assumed to have greater long-term impact on the introduction of LNG than the stronger market incentive under Reactive Path prices

Policies trump markets in the Balanced Future scenario:

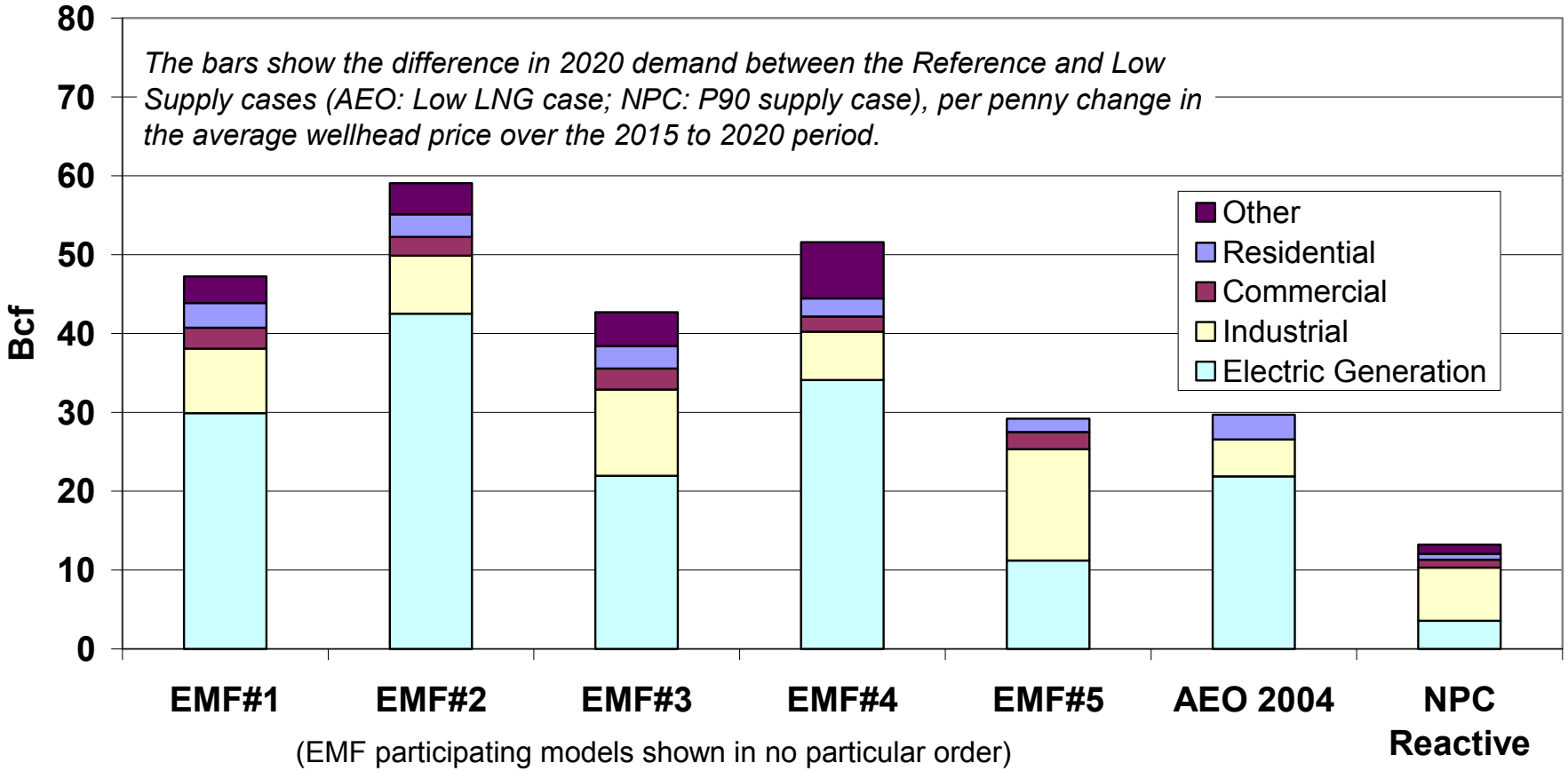
Example: Electric Demand, Capacity

- Electric demand is assumed to grow at a slower rate than under Reactive Path, due to policy measures to increase efficiency of electric use
  - Impact of higher gas prices on electric cost and demand is ignored; rough estimate: price impact could be 3X assumed difference between scenarios due to efficiency
- Gas prices are lower, but less gas-fired capacity is added, and more oil, coal, nuclear, and renewables capacity is added, than under Reactive Path, due to policies encouraging use of these other fuels

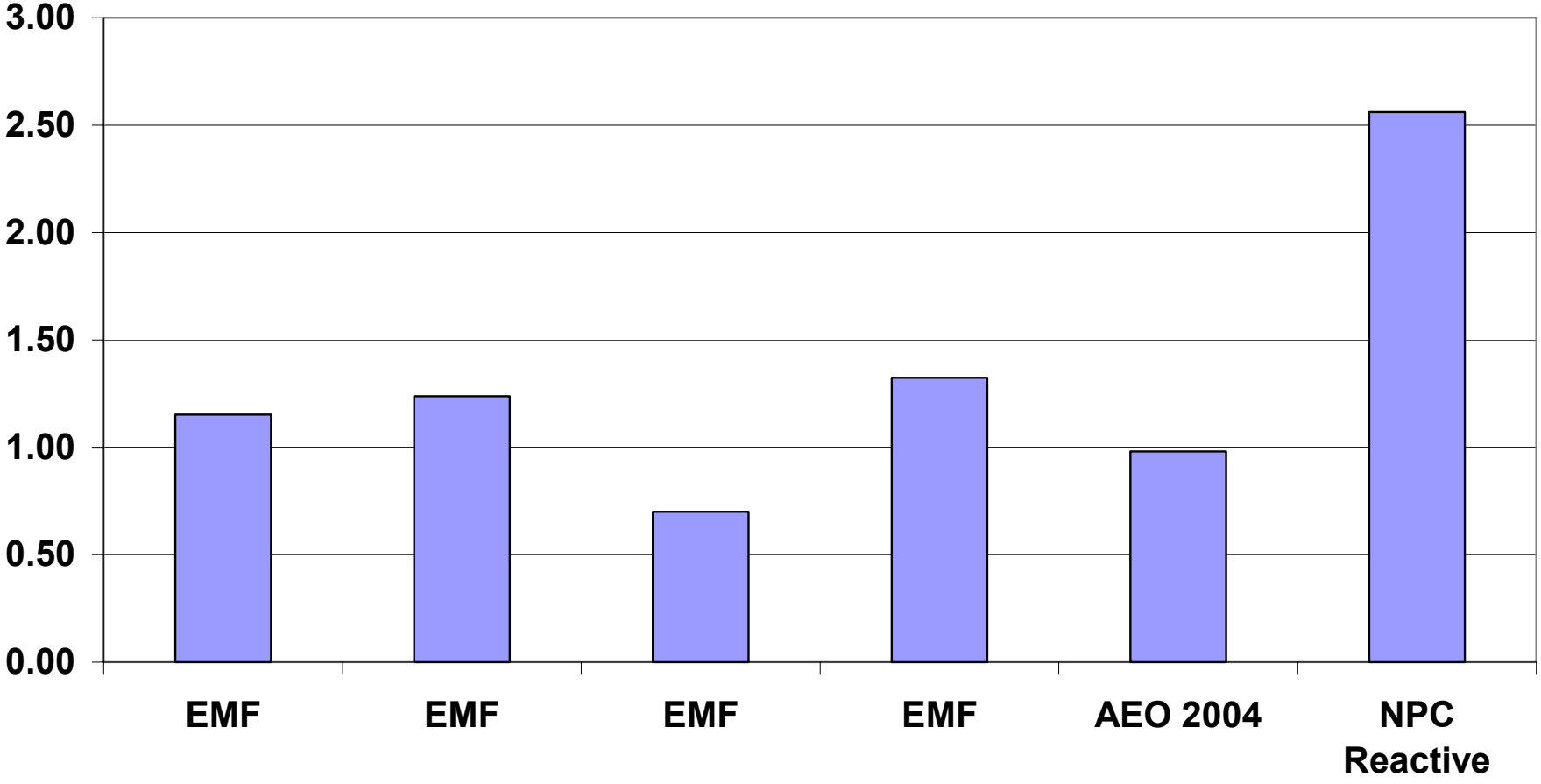
Supply Response to Higher Prices, 2020



Demand Response to Higher Prices, 2020



Ratio of Natural Gas to Crude Oil Price, 2020



Natural Gas Forecasting: Risky Business

- Forecasts, and the recommendations they imply, can change quickly. Example: NPC 1999 and 2003 reports:
  - 1999 Report: "Sufficient resources exist to meet growing demand well into the twenty-first century"; recommended policies included encouraging gas use
  - 2003 Report: Resource base reduced 20%, will meet only 75% of a lowered consumption forecast (-15%); price forecast increased 40% to 70%; recommended policies now reduce demand more than they expand supply
- Recent spot and forward market volatility suggest an unusually high degree of uncertainty at present; so major policy initiatives are especially risky, there is value to waiting.

Limited Scope of NPC Policy Analysis

- Focus on one, “all-or-nothing” policy package
  - The various recommended policies are largely substitutes (in increasing supply or reducing demand), and a small subset may provide a majority of the impact
  - Alaska pipeline v. LNG v. unconventional resources, etc.
- Focus on gas price and cost to gas consumers
  - Other important impacts of policies were not addressed (on the environment, taxpayers, producer profits, supply security; costs shifted to other sectors, etc.)

Summary

- The NPC Study is a major contribution to understanding natural gas supply, demand and policy options
- The NPC modeling understates markets' long-term reactions, and overstates the impact of and need for government policy initiatives
- The scope of the NPC policy evaluation was limited – it does not provide a full picture of policy costs and benefits
- Major policy commitments are especially risky in the current, highly uncertain market environment

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