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Generation Trends – What Are the Impacts on Transmission?

Infocast Transmission Summit West 2012

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Witches Brew…Or Love Potion #9

Gas
Low, stable prices as far as the eye can see? Or not?

EPA
All of the above…except coal
Which leaves?

Midstream Resources
Does design basis = current use case?

Electric Gas Coordination
No problem or big deal?

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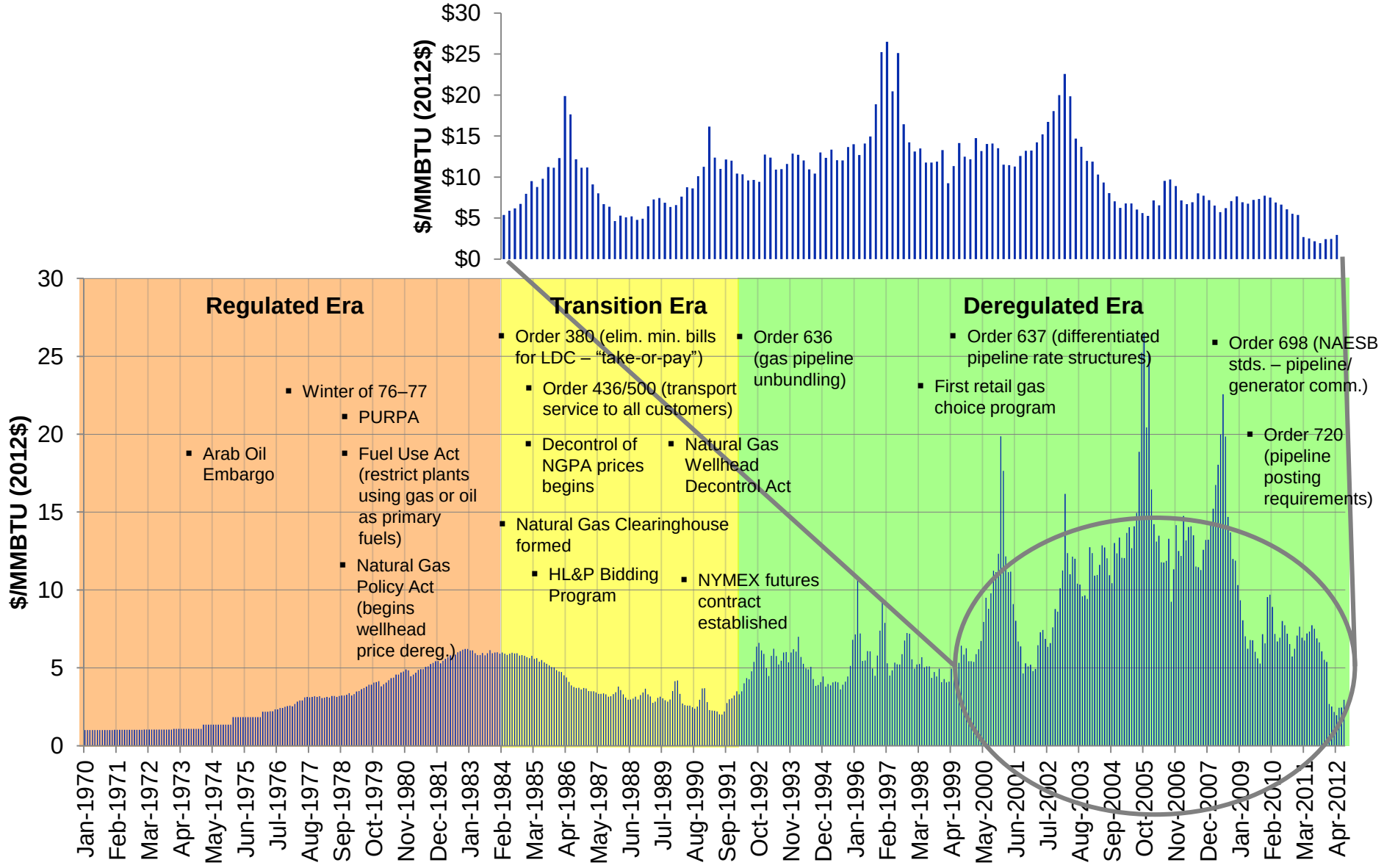
Trend 1 – Gas
U.S. Natural Gas Real Spot Prices (Henry Hub) – A History of Price Volatility



Sources: World Bank Commodity Price Data, adjusted by CPI to 2012 dollars; NERC; naturalgas.org

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Trend 1 – Gas
Natural Gas Prices – Kinda Hard to Predict

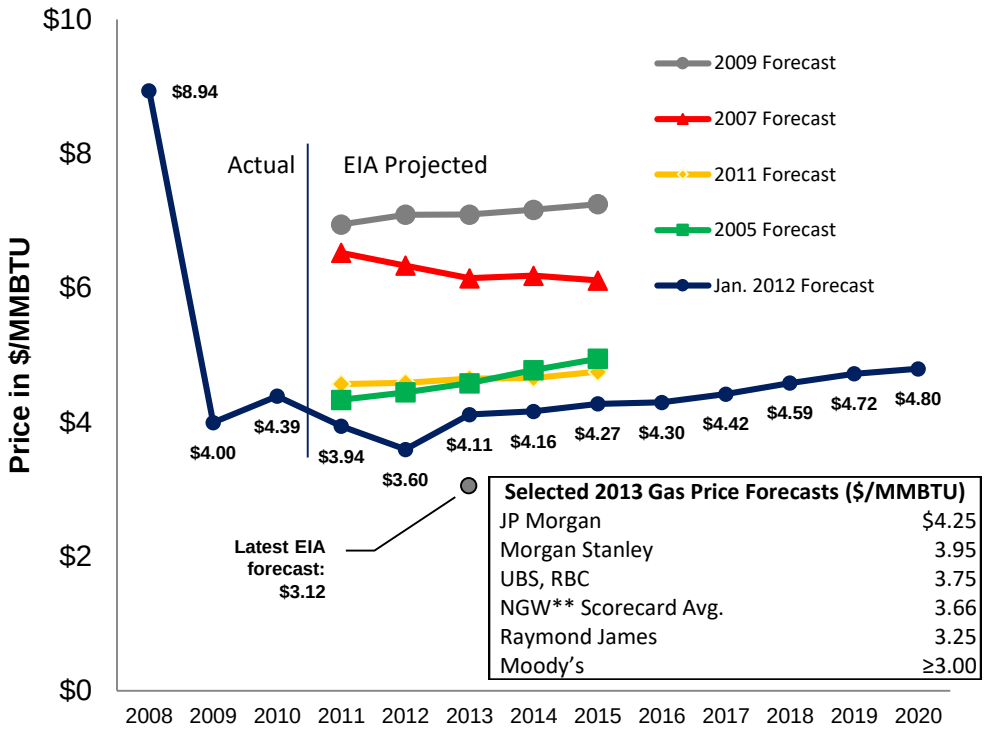
Gas Prices Remain Depressed

- Natural gas prices are not projected to return to pre-recession levels in the near to intermediate term
- U.S. government forecasts (shown right) reflect steady 2%+ per year growth
- Some contrarians, however, posit $6/MMBTU natural gas by 2015

Demand May Pull up Prices, but Supply Response and Impact of Worldwide Demand Create Uncertainty

- Industrial gas demand: Slow increase in the medium term, tempered by the sluggish U.S. economy
- Short-term gas demand from power generation is projected to increase, but that demand growth levels off longer term (~10 years)
- More Canadian gas may go to Asia as LNG export facilities in western Canada emerge to take Canadian gas traditionally exported to the United States—now displaced by shale gas
- Some big question marks: the impact of production efficiencies, drilling inventory, and gas demand response

EIA Actual and Projected Henry Hub Average Spot Price and Selected Forecasts ($/MMBTU*) (in 2010$)



Selected 2013 Gas Price Forecasts ($/MMBTU)	
JP Morgan	$4.25
Morgan Stanley	3.95
UBS, RBC	3.75
NGW** Scorecard Avg.	3.66
Raymond James	3.25
Moody's	≥3.00

Despite the apparent smooth trajectory, gas price volatility may remain, driven by pipeline constraints, increased gas consumption for power generation, and changing basis relationships.

Notes: *2005 forecast is in $/MCF and is an average wellhead price, not a Henry Hub average price.
**_Natural Gas Week_ (Aug. 6, 2011).

Sources: Industry news; EIA; IEA; FERC; SNL Financial; _Natural Gas Week_

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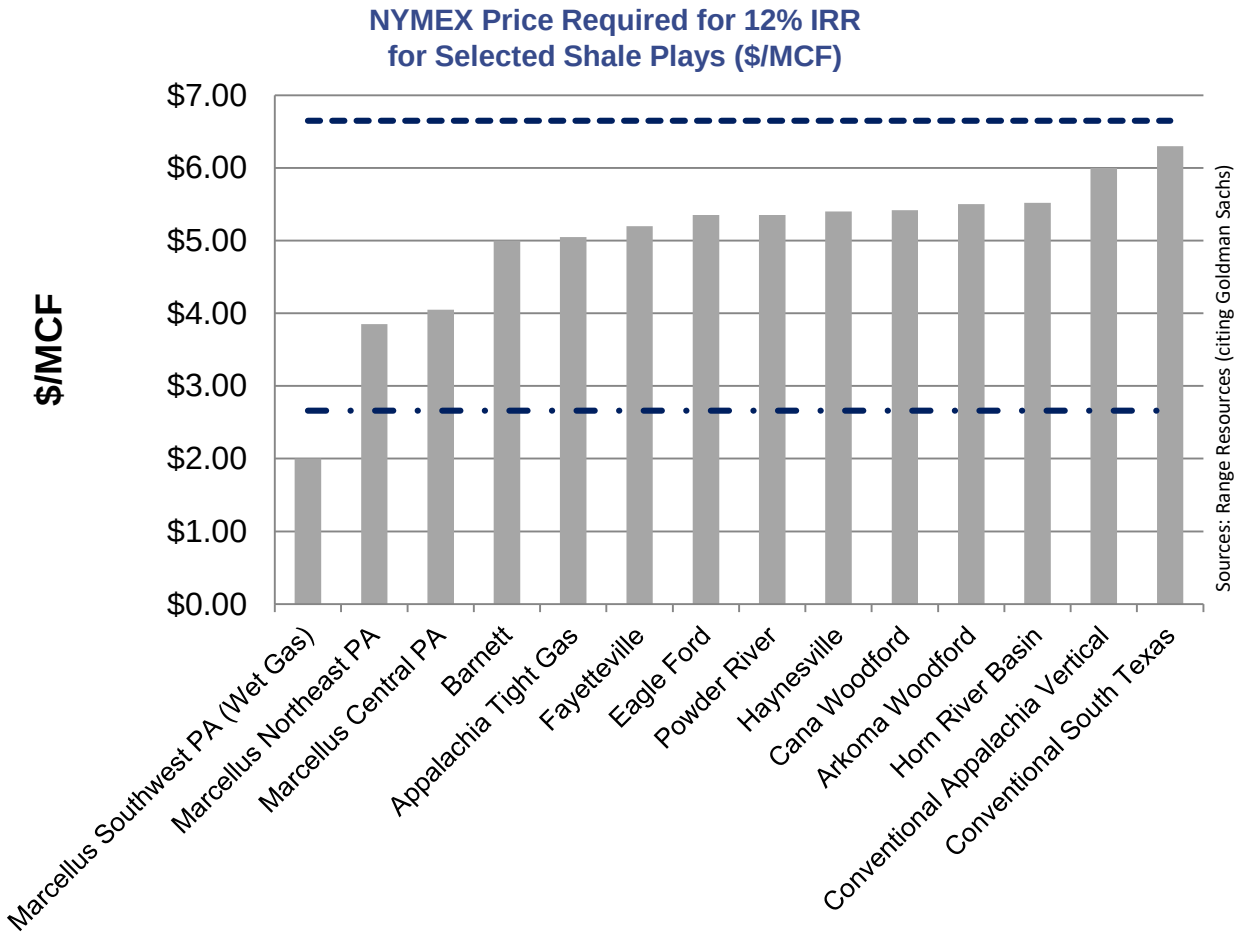
Trend 1 – Gas
Breakeven Costs Suggest Future Volatility Is Possible...



Sources: Range Resources Company Presentation (Oct. 2011) (citing Goldman Sachs); *Carol Freedenthal, Jofree Consulting, quoted in *Natural Gas Week* (Oct. 31, 2011); El Paso Midstream; Kinder Morgan; Enterprise Products Partners; PennEnergy; Reuters: SNL Financial (historical gas strip prices)

Shale Gas Economics Remain Favorable

- Shale play economics have been resilient, even with abundant supply and "rock-bottom" prices
- Natural gas liquids (NGLs) continue to buoy economics of "wet" plays like Marcellus and Barnett
- Some supply response emerging (e.g., Chesapeake pull-back)?

Utica—The Next Big Shale Play?

- Utica Shale, a 170,000 square mile formation deeper than the Marcellus, is seen by some as the next major shale play
- ExxonMobil, Chesapeake, Hess, and others are making significant investments in leases, largely in Ohio
- Little production to date, so Utica's productivity is uncertain

"Natural gas is going to enter a golden age we haven't seen since the 1950s."
Bob Best, Executive Chairman, Atmos Energy

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Trend 1 – Gas …And the Predicted Supply Response May Be Taking Place

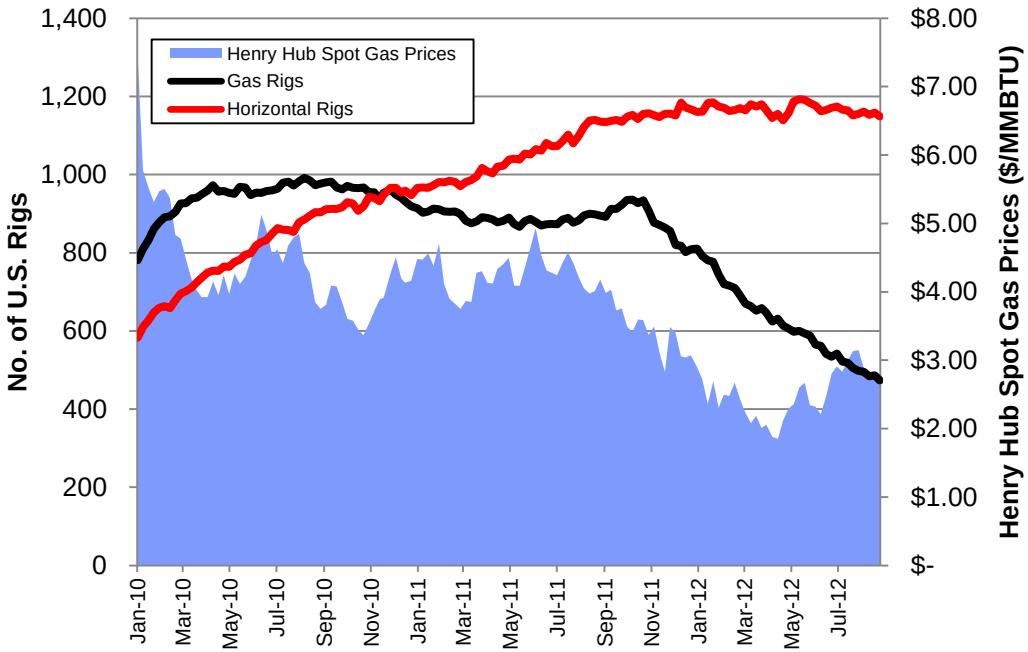
Drilling Pullback Started with Sub-$3 Gas

- Some producers are pulling back dry gas production
- Gas rigs are being repurposed for oil production
- Some recent announcements:
  - Chesapeake: “Bare minimum” levels
  - Conoco: Shutting in 100 MMcf/day
  - EQT: Suspends gas drilling indefinitely in Huron, coalbed methane plays in App. Basin
  - Quicksilver: Focusing on oil, liquids projects
  - Noble: Low price “circuit-breaker” tripped; suspending dry gas production in Marcellus until $4/MMBTU gas for three consecutive months
- Others are continuing, or at least remaining mum
- Curtailment or supply response?

LNG Safety Valve?

- Landed LNG in European hubs exceeds $11/MMBTU, Japan exceeds $17/MMBTU
- With transport and regas ~$2/MMBTU, prolonged low ($3) domestic gas prices could energize a U.S. LNG export market
- Varied opinions

Rig Count vs. Spot Gas Prices (Jan. 2010–Aug. 2012)



Lag effect: As recently as mid-February, domestic production was up from last year (nearly 20%) but trending downward as Canadian imports and LNG imports have been reduced significantly (down nearly 30% and 50%, respectively, from Winter 2011). As rigs are reduced, one might expect a continued ramp-down in domestic dry gas production.

Sources: EIA; Baker Hughes; Energy Intelligence *Natural Gas Week*

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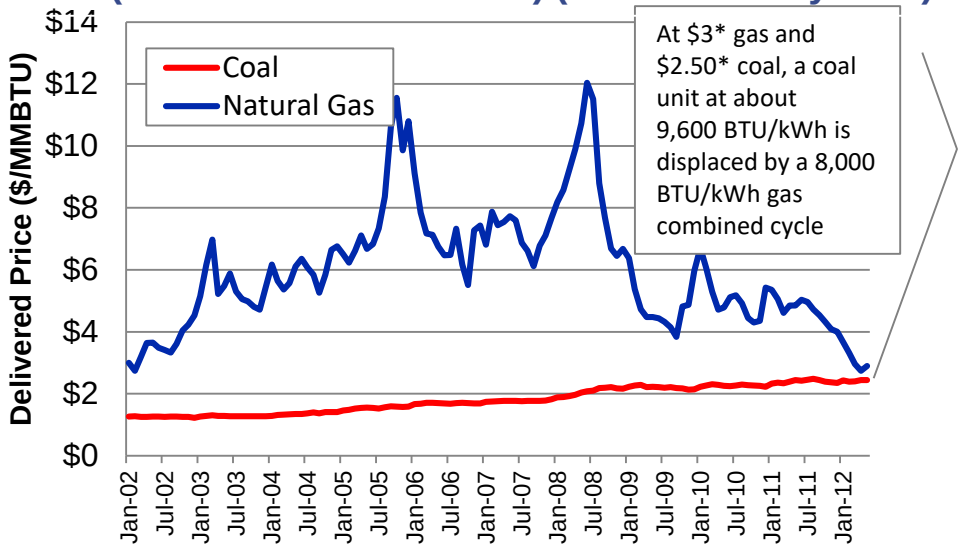
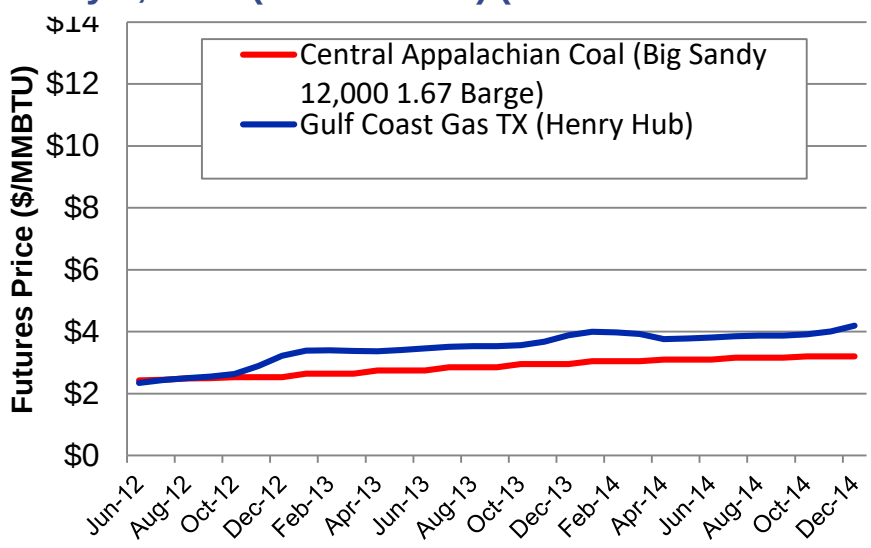
Trend 1 – Gas
Coal Versus Gas: The Switch Goes On

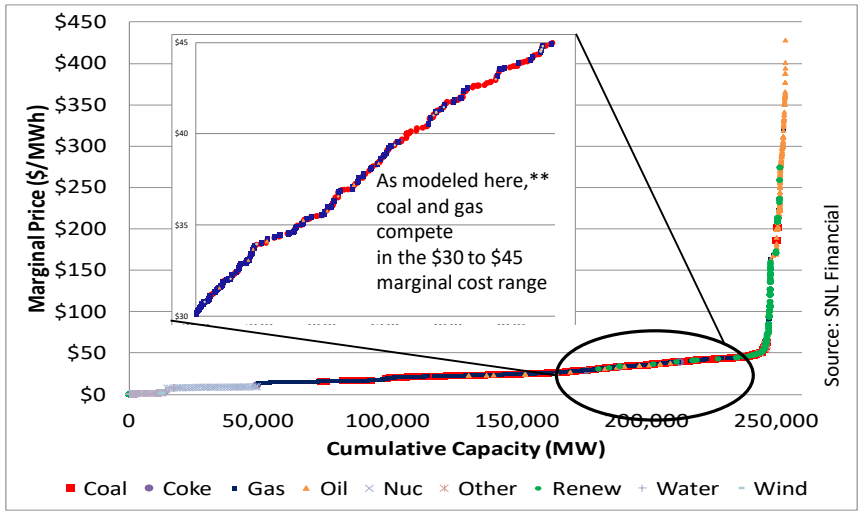
Monthly Cost of Fuel Receipts at U.S. Electric-Generating Plants (in $/MMBTU incl. Taxes) (Jan. 2002–May 2012)



Illustrative NYMEX Coal and Gas Futures Prices as of May 3, 2012 (in $/MMBTU) (Jan. 2012–Dec. 2014)



Example Plant Dispatch Curve** – SERC Region



Fuel Mix of Top 10 U.S. Generators	Coal Share of Total Gen 2010	Coal Share of Total Gen 2011	Gas Share of Total Gen 2010	Gas Share of Total Gen 2011
Southern Co.	57%	51%	25%	30%
NextEra Energy	4%	3%	51%	57%
American Electric Power	81%	77%	8%	11%
Exelon	5%	3%	1%	1%
TVA	49%	47%	7%	8%
Duke Energy	60%	57%	7%	10%
Entergy	13%	12%	23%	25%
FirstEnergy	64%	70%	0%	0%
Dominion Resources	38%	32%	14%	19%
Progress Energy	45%	36%	29%	32%

Notes: *Per MMBTU.
**Assumes 20% var. O&M, wind at 33% availability; zero marginal cost for hydro.
Sources: EIA; SNL Financial; ScottMadden analysis

Trend 2 – EPA
All of the Above...Except Coal –
EPA Rules: The Big Three

Proposed Rule	Affected Units	Requirements	Implications and Issues
Cooling Water Intake under Clean Water Act §316(b) (final rule delayed until June 2013)	◆ Power generation, manufacturing, and industrial facilities ◆ Use 25%+ of water for cooling and two million gallons/day	◆ Site-specific Best Available Control Technology (BACT) for impingement and entrainment mortality ◆ Not "one-size-fits-all"	◆ EPA estimates 257 affected facilities at <u>average</u> cost of $0.7 to $8.9 million per facility ◆ ERCOT est. for closed loop cooling tower: $200/KW ◆ Closed loop for new; perhaps for existing?
Mercury and Air Toxics Standard (MATS) (final standards released in Dec. 2011; for new plants, revised rule pending, due Mar. 2013)	◆ New and existing coal- and oil-fired utility steam generating units ◆ Natural gas plants <u>not</u> affected	◆ Cut 91% of mercury and limit acid gases, other metals, particulate matter ◆ Maximum Achievable Control Technology (MACT) ◆ Three-year compliance window; possible (rare) one-year extension	◆ Per EPA, affects 1,350 coal- and oil-fired units at 525 plants ◆ May require scrubbers on all coal units
Cross-State Air Pollution Rule – CSAPR (issued July 2011; 2012/14 implementation; stayed Dec. 30, 2011; rule vacated by D.C. Circuit, Aug. 21, 2012; EPA has until early Oct. to appeal)	◆ Power plants in 28 affected states (including late entrant TX) ◆ Per EPA, affects 3,632 electric generating units at 1,074 coal-, gas-, and oil-fired facilities	◆ Defined state (not regional) SO_2, NO_x emissions budgets for "upwind" contribution to "downwind" non-attainment	◆ Likely requires state-of-the-art SO_2 and NO_x controls ◆ Pending appeal with expedited timing — Jan.: Briefing plans — Apr.: Hearings — July–Aug.: Decision expected ◆ For now, CAIR remains in effect—2012 dif. in emissions budget — SO_2: + <1% — NO_x: +15% — Ozone season NO_x: +14%

Sources: EPA; Van Ness Feldman; Bryan Cave; World Resources Institute; industry news

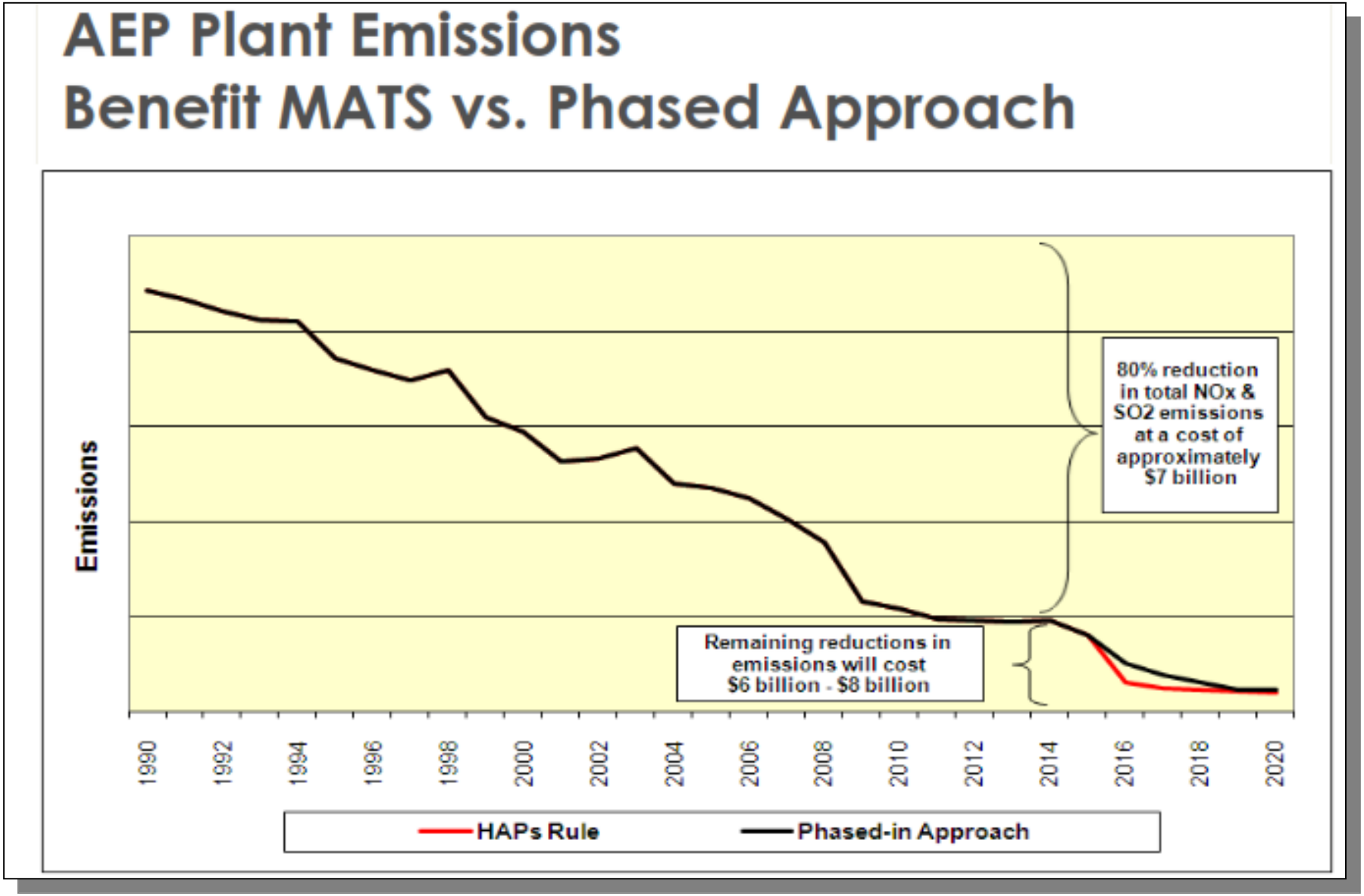
Strong industry reaction. Political and judicial arm wrestling. Invest or retire?

Trend 2 – EPA All of the Above...Except Coal – EPA Rules: Plus Two

Proposed Rule	Affected Units	Requirements	Implications and Issues
Coal Combustion Residuals Treatment as Solid or Hazardous Waste (proposed June 2010)	◆ To be determined	Two alternatives proposed: ◆ Hazardous waste: comprehensive waste program, federally enforceable ◆ Solid waste: EPA performance standards for coal ash handling facilities; state enforcement; wet handling of coal ash through impoundments with liners	◆ Concerns that hazmat label will send more CCRs to landfills rather than beneficial use ◆ Uncertainty about states ability to manage this along with other changing EPA standards
Greenhouse Gas New Source Performance Standards for Electric Generation (proposed Mar. 2012; EPA not expected to act on final rule until after election)	◆ New fossil-fired steam and combined-cycle generating units >25 MW ◆ Explicitly excludes existing units or modifications or reconstructions of existing units ◆ Some believe rules may apply where existing plants are modified in a way that increases their hourly rate of emissions	◆ Proposed cap of 1,000 pounds of CO_2 per MWh ◆ Pegged to natural gas combined cycle (EPA: 95% of NGCCs constructed between 2006 and 2010 met standard) ◆ Allows construction of new generation with commitment to later install CCS equipment, but no one believes this is practical now ◆ Grandfathers "transitional units"—new generation with pre-construction permits and begins construction by late March 2013	◆ Effectively eliminates new coal plants: Without CCS cannot meet standard; implicitly assumes CCS costs will decline, be at commercial scale within 10 years ◆ EPA assumptions: ◆ Most new units would be gas-fired given low gas prices ◆ New coal attractive over NGCCs at $9.60/MMBTU gas ◆ But assumes coal by comparison would cost between $9 and $50/MWh in "pollution damages"

Could GHG new source rules morph into a modification standard that affects existing generation more profoundly than EPA says?

Trend 2 – EPA
Cost of EPA Rules



Source: AEP, conference presentation, 10/9/12 SNL Electric Generation Conference

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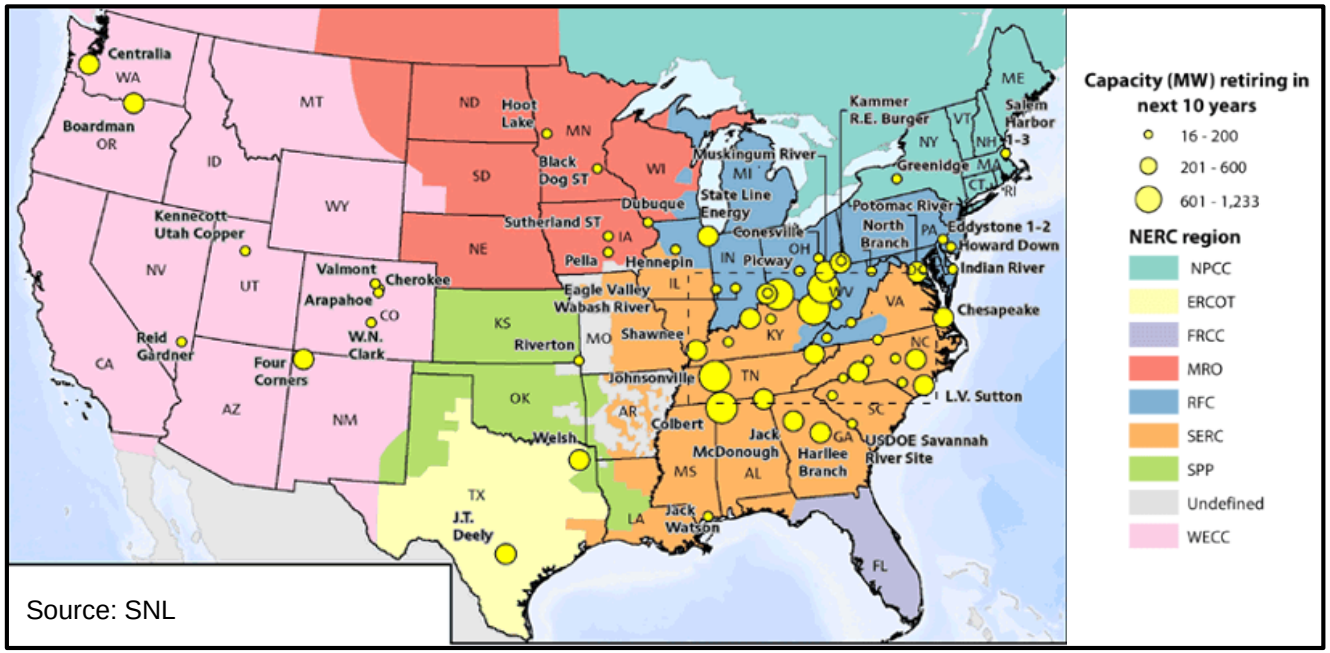
Trend 2 – EPA
All of the Above...Except Coal –
EPA Rules = Massive Coal Plant Retirements?

More than 30 GW Announced Retirements in Next 10 Years

- U.S. power companies have formalized plans to retire 30,321 MW of coal-fired generating capacity between 2012 and 2021
- This figure is up from a March 2012 estimate of 25,000 MW of coal capacity retirements during the same period



Source: SNL

- Divergent estimates on coal plant retirements
  - — EPA only looked at each regulation, not the combined effect
  - — Final rule more aggressive than draft
- Some post-Cross-State Air Pollution Rule coal generation retirement analyses
  - — EPA: 4.8 GW (1% of capacity); no impact on power prices
  - — Bernstein: 60 GW by late 2015 (combined CAIR and MATS)
  - — Black & Veatch: 65 GW, 50 GW in the Eastern Interconnection
  - — Burns & McDonnell: 40 to 50 GW
  - — EPRI: 61 GW between 2010 and 2035; 54 GW "on the fence"
  - — Friedman Billings Ramsey: 50 GW to 55 GW by 2018, largely due to MATS
  - — Fitch: 83 GW (combined rules effects)
  - — Guggenheim Securities: 50 GW by 2015 (combined rules effects)
  - — ICF: 70 GW of retirements (combined rules effects)
  - — Wood Mackenzie: 78.7 GW by 2033

Sources: Deutsche Bank; FitchRatings: Sanford C. Bernstein; SNL Financial

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Trend 3 – Midstream Gas System
Does Design Basis = Current Use State?

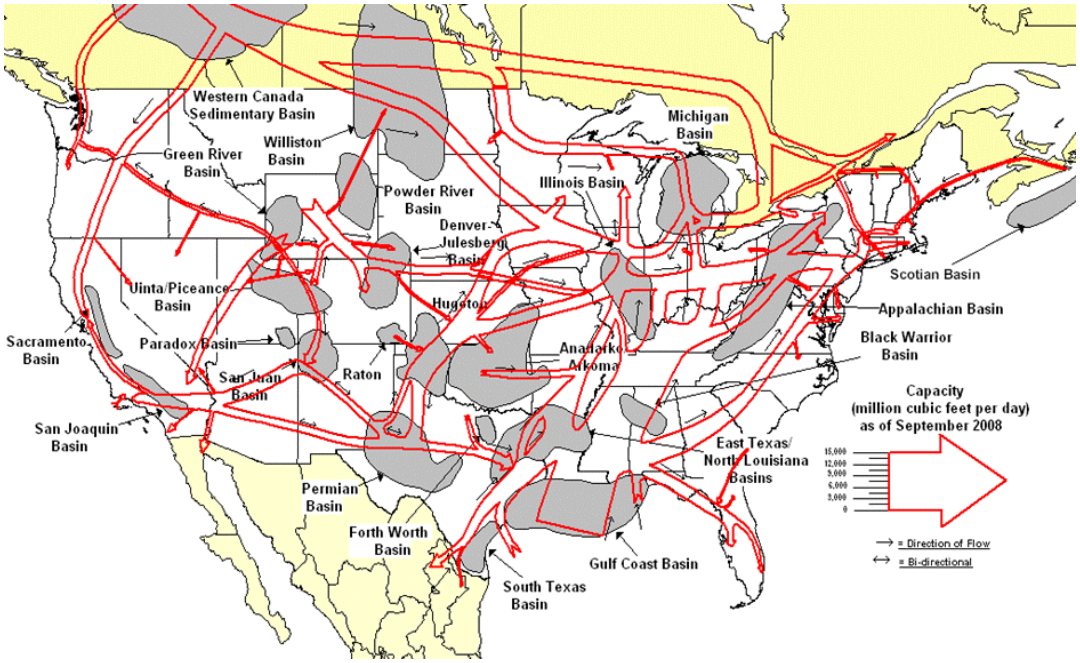
New Pipelines Needed; NGLs Are Current Focus

- Pipeline expansions proposals: Marcellus and other shale plays
- Some liquids-focused pipelines moving NGLs to the upper Midwest and Canada or Gulf Coast
- Expansion of dry natural gas pipelines to East Coast urban centers could be contentious: ROW negotiations, new battleground for fracking opponents

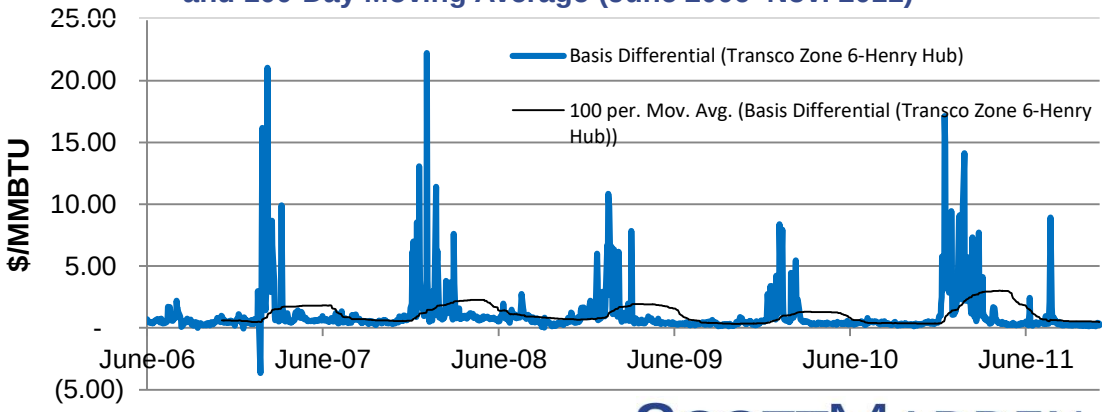
Additional Capacity, Basis Changes?

- Approximately 6 BCF/day in new gas pipeline capacity proposed for Marcellus
- With new pipeline capacity from shale gas resources to markets, basis relationships may change
- Falling premiums: NY, New England vs. market centers like Henry Hub
- But increased gas-fired generation along with winter heating demand may continue to constrain pipeline capacity, leading to volatile winter gas prices

Pipeline Capacity from Selected Basins to Selected Demand Centers as of Sept. 2008 (BCF/Day)



Basis (Price) Differential—NY Transco Zone 6 (NYC) vs. Henry Hub and 100-Day Moving Average (June 2006–Nov. 2011)



Sources: EIA; FERC; Morgan Stanley; Credit Suisse; SNL Financial; ScottMadden analysis

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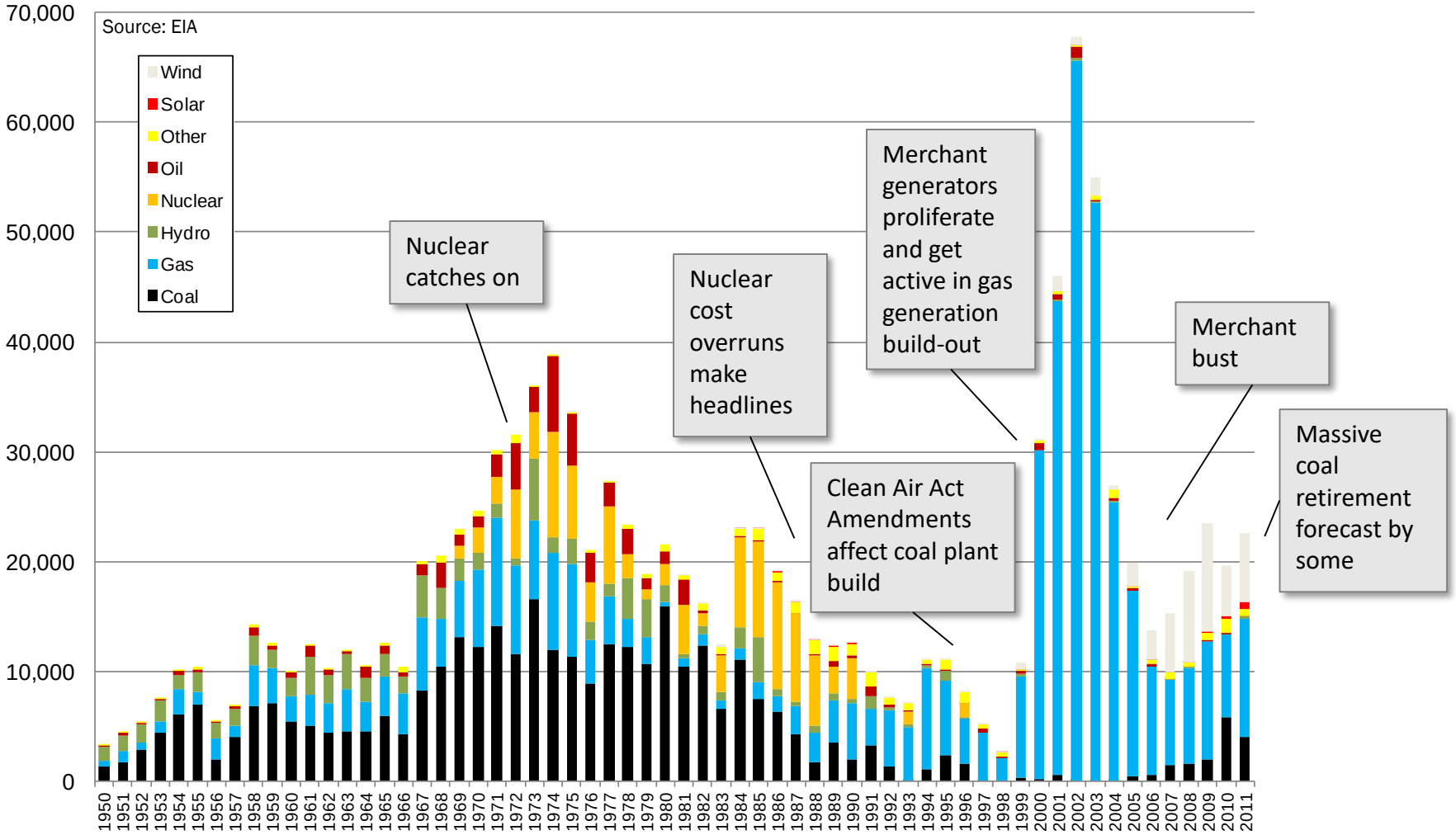
Trend 4 – Midstream Electric-Gas Coordination – No Problem or Big Deal?

- Firmness of gas contracts and contracting method; potential for common mode failure
  - If the gas isn't firm, can the capacity be? Transmission N-1 and N-2 planning excludes pipeline loss
    - Multiple gas plants depend on single pipeline; can be coupled with coincident heating load peak (TX 2/2/2011)
    - Motor-driven compressors need power
    - The building of new pipelines to full utilization (anchor tenant vs. fully subscribed model)
      - In electric, we like reserve margin
  - Biggest issues may be in bid-based markets; vertically integrated utilities can recover firm gas costs in rates
- Response speed, intra-hour and intra-day responsiveness, volumetric volatility, high pressures needed by new CCs
  - Gas travels at 20 mph; electricity must be balanced instantaneously
  - Storage can help, but still has some "speed limits" on working gas withdrawal
  - Electricity demand ramps more rapidly than pipeline delivery cycles
    - High pressure needs of CCs can exhaust line packs quickly; line packs are built up overnight
    - A CC can look to a pipeline like a city the size of St. Louis or San Antonio, limiting grid flexibility to react abruptly
- Location, location, location
  - Pipelines built to move gas from old production centers to heating loads in population centers
  - Now supply is in a different place; so is demand from electric generation, the fastest growing gas demand component
  - Storage is concentrated geographically; generation is not
- Market operations and scheduling
  - Scheduling day mismatch; generators cannot order in time to secure their dispatch commitments
- Code of conduct and communications
  - Communications and coordination is not what it should be
  - And some of what it should be may be illegal, due to revealing sensitive electric transmission information
  - But NAESB with FERC approval has relaxed some of the code of conduct constraints if reliability will be impacted

Portfolio Diversity and the Nation's Power Supply Déjà Vus All Over Again?

Current U.S. Operating Power Generation Capacity by Fuel and Initial Operating Date (as of Year-End 2011)



Notes: Excludes capacity in operation before 1950. 2011 data are preliminary and incomplete; pending EIA update.
Hydro is run-of-river and pumped storage; excludes tidal, etc. Coal includes lignite and refined coal, but does not include petcoke, black liquor, and the like. Gas does not include propane or syngas. Oil includes residual, distillate, and "other" oil, which includes waste oil products like butane, sludge oil, tar oil, and propane.

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Supply Shakeup – Is Transmission Ready?

Planning Cycles

- Traditionally long lead time for developing and constructing transmission may not keep pace with generation requirements as driven by new regulations
- Varied planning horizons for different asset types complicates transmission planning
- Assets currently contemplated have unique operating characteristics (operate based on pricing, load, contracts—not system conditions)
- Assets are being added to the resource mix that may not actually operate under all scenarios

Operations

- Retirement of larger or strategically placed units may cause changes to power flows and stability dynamics
- Enhancements and investments to transmission systems may be needed to provide reactive and voltage support, address thermal constraints and provide system stability

Outage Coordination

- Given tight window for compliance, many units that will be retrofitted may need to take concurrent long-term maintenance outages, causing resource adequacy concerns

New generation, outages for retrofits, and required transmission must be coordinated in order to ensure continued bulk system reliability

Sources: NERC 2011 Long Term Reliability Assessment; Industry news

Closing Thoughts

- Supply uncertainty is at unprecedented levels
  - Is your current transmission plan based on generation assumptions that are less certain?
- The mismatch in planning cycles between supply and transmission makes it unlikely that all major assumptions made at the beginning of the transmission planning cycle will still be true when facilities come on line
  - And, almost inconceivable that they will remain true for the 50-year useful life
  - This is exacerbated by the number of players planning supply and, increasingly, transmission
- Despite this uncertainty, we are embarking on another step-function increase in transmission build
  - This is needed in part because of the backlog and long latency between planning and reality
  - Is the transmission planning and development process flexible enough to accommodate the policy mandates currently in place or coming?
- During the 10-year transmission planning horizon (possible), and almost certainly during the 50-year useful life:
  - Disruptive technologies will be introduced (or a lot of VC money will go down the drain)
  - Discontinuous public polices and market rules will be enacted
- This unprecedented uncertainty makes planning more challenging than ever before, especially for transmission
- Our advice
  - Maintain a questioning attitude
  - Make assumptions and conventional wisdom explicit—and challenge them!
  - Consider more than one state of the world

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Electric Gas Coordination
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Perhaps a bit of both...depending on how we coordinate timing, constraints, and opportunities

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