ScottMadden
Management Consultants

Supply Trends – What Are the Impacts on Transmission?

Infocast Transmission East Summit 2012

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Outline

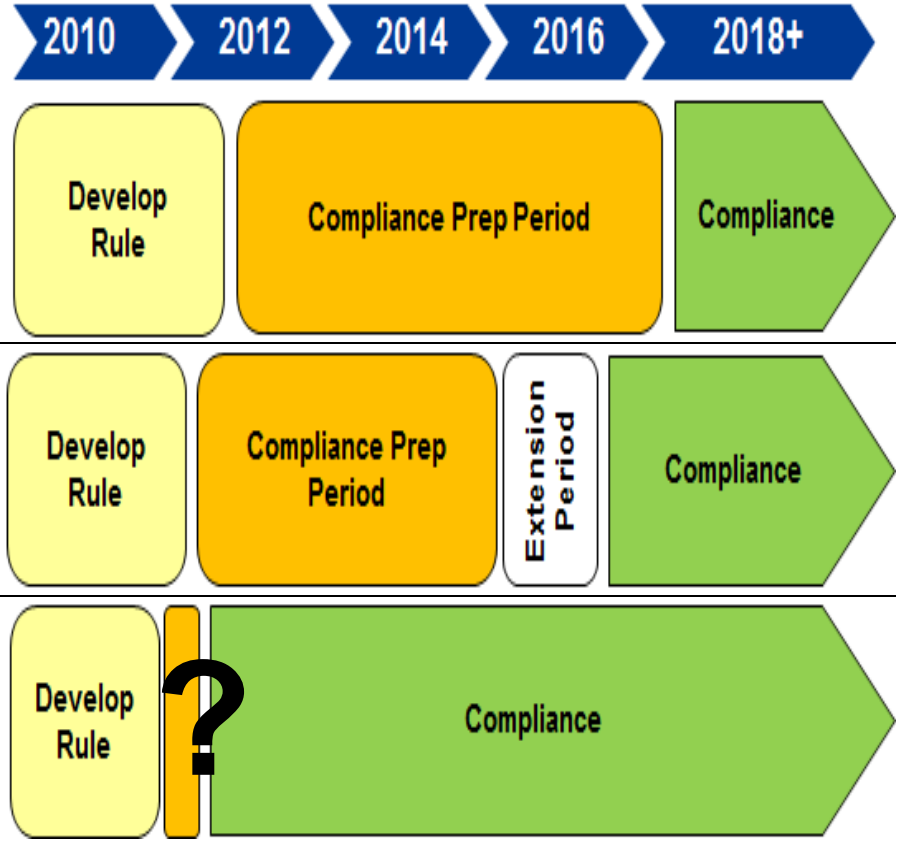
- Environmental Regulations ï Fixed or Fleeting?
- Generation Technologies ï Where is the Silver Bullet?
- Planning Reserve Margins ï Feast or Famine?
- Supply Shakeup ï Is Transmission Ready?
- Case Study: A Tale of Two Retirements
- Closing Thoughts

Environmental Regulations – Fixed or Fleeting?

Major Implications

Proposed Rule	Implications and Issues
Cooling Water Intake under Clean Water Act §316(b) (final rule by July 2012)	◆ EPA estimates 257 affected facilities at <u>average</u> cost of $0.7 to $8.9 million per facility ◆ Closed loop for new; perhaps for existing?
Air Toxics Rule (final standards released in Dec. 2011)	◆ 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 (issued July 2011; 2012/14 implementation; stayed Dec. 30, 2011)	◆ Per EPA, affects 3,632 electric generating units at 1,074 coal-, gas-, and oil-fired facilities ◆ Likely requires state-of-the-art SO_2 and NOx controls

Short Compliance Timelines



Negative Economics

Big Coal Retrofit	$800/kW	**Small Coal Retrofit**	$1,700-$2,400/kW	**New CCGT**	$800-$1,200/kW	**Used CCGT**	$400/kW

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

Sources: EPA; Van Ness Feldman; Bryan Cave; World Resources Institute; NERC 2011 Long Term Reliability Assessment; Industry news

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Environmental Regulations – Fixed or Fleeting? (Cont'd)

Rhetoric

- "Studies demonstrate that regional reserve requirements could be compromised by the cumulative impact of EPA's actions, which indicate that between 2012 and 2018, the nation's power grid will be stressed in ways never before experienced and could pose a reliability concern." *NERC, 2011 Long Term Reliability Assessment*
- EPA's regulations will result in "only a modest level of retirements. EPA rules have never caused the lights to go out and they won't this time. No one is suggesting that there won't be localized reliability issues, but we don't need to choose between reliability and pollution." *Gina McCarthy, EPA Assistant Administrator for Air and Radiation*
- "There is just no way in the world you can make a rule final in 2011 and expect people to comply with it by January 2012. It is as close to lunacy as you can get." *Mike Morris, Chairman and CEO, AEP*
- "Provides needed regulatory certainty and can be implemented on time without threatening reliability." *Exelon Press Release*

Litigation

- States and generators have sought stays of all three EPA proposed rules

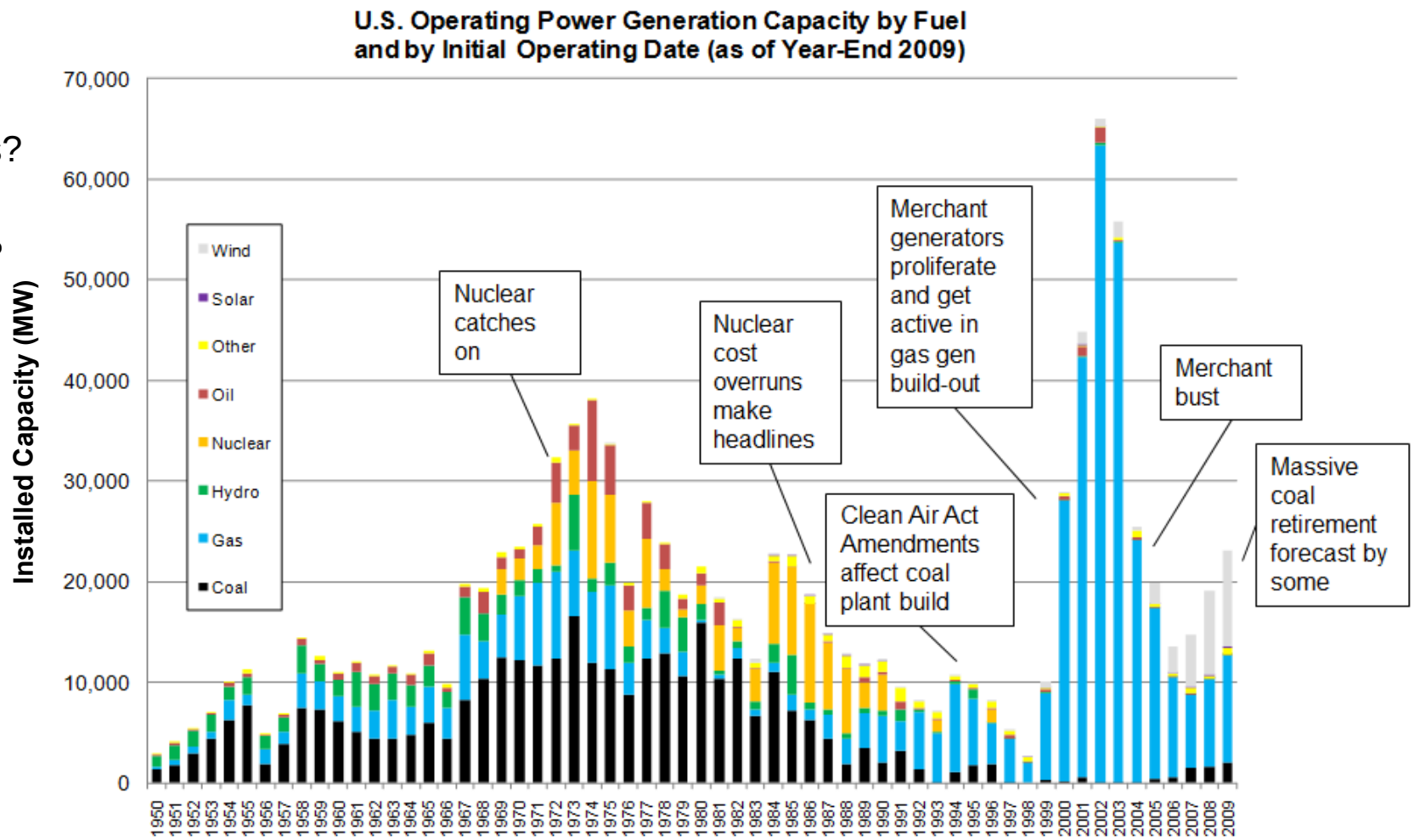
Legislation

- U.S. House leaders had already been battling EPA over GHG regulation
- Legislative solution is unlikely, at least prior to the Presidential election

Sources: SNL Financial; Roll Call; National Journal, EPA

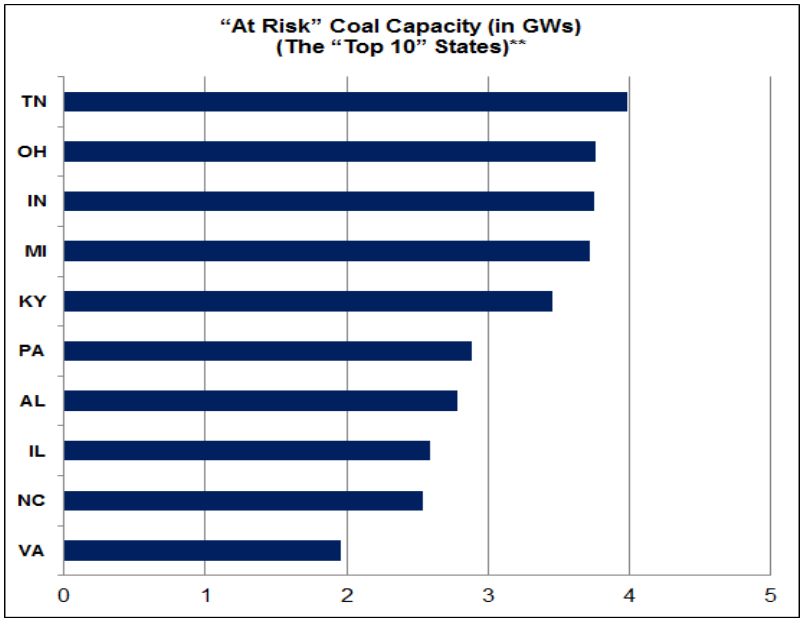
Generation Technologies – Where is the Silver Bullet?

- Coal?
- Nuclear?
- Renewables?
- Distributed Generation?
- Gas?



Source: EIA
Note: Excludes capacity in operation before 1950.
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.

King Coal – Dead or Dethroned?



- Divergent estimates on coal plant retirements
  - EPA only looked at each regulation, not the combined effect
  - Final rule more aggressive than draft
- Based on combined effects, NERC project incremental coal capacity losses averaged between 10 to 23 GW through 2018
- Some post-Cross-State Air Pollution Rule coal generation retirement analyses
  - EPA: 4.8 GW (1% of capacity) and no impact on power prices
  - Bernstein: 32 GW (9% of U.S. coal-fired capacity)
  - Burns & McDonnell: 40 to 50 GW
  - Bentek: 50 GW retired or converted to gas
  - Black & Veatch: 65 GW
  - Fitch: 83 GW (combined rules effects)

Top 10 states "At Risk" are in the Eastern Interconnection

Note: *Utility Maximum Achievable Control Technology/National Emissions Standards for Hazardous Air Pollutants
**As of May 2011, before release of final rule

Sources: Deutsche Bank; FitchRatings: Sanford C. Bernstein; SNL Financial ; NERC 2011 Long Term Reliability Assessment, Table 34

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King Coal – Dead or Dethroned? (Cont'd)

There are a significant number of U.S. coal-fired plants without an Air Quality Control System (AQCS) (SCR and FGD) installed, representing a significant amount of supply capacity

Years Built	# of Units W/O SCR and FGD	Nameplate Rating (GW)	Average Capacity Factor
Since 1970	131	42.8	72%
1960ï 1970	441	21.4	52%
1950ï 1960	305	14.2	50%
Before 1950	44	2.8	27%

But a significant number of units could potentially be shut down with minimal total supply impacts

Capacity Factor	# of Units W/O SCR and FGD	Average Nameplate Rating (MW)	Total Nameplate Rating (GW)	Average Year Built	Average Heat Rate (BTU/kWh)	GW Lost by Closure (%)	GWHr Lost (%)
<60%	305	145	48.2	1958	11,239	14.1%	11.9%
<50%	167	123	20.5	1956	11,626	6.0%	4.2%
<40%	85	83	7.0	1952	12,202	2.0%	1.1%
<30%	51	71	3.7	1947	12,951	1.1%	0.4%

Impact on grid reliability is a different question, and one that is challenging to examine systematically

Source: *Power Magazine*, April 2011, NETL database, EIA Form 860

Nuclear Renaissance – Deferred or Done?

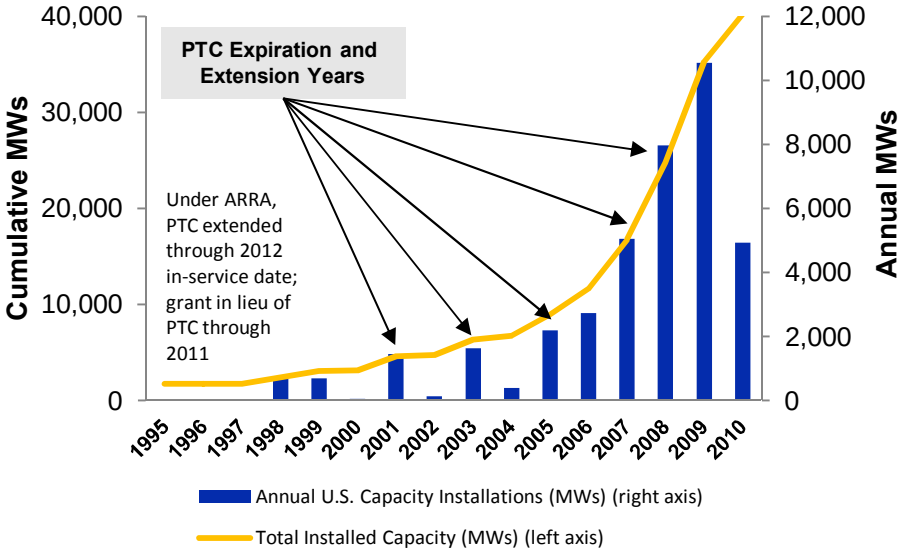
- NRC Fukushima task force recommendations
  - ð 10 recommendations, including:
    - Strengthen station blackout mitigation
    - Enhance spent fuel pool makeup capability/monitoring
    - Strengthen on-site emergency response
- NRC is considering requiring nuclear power plant operators in the U.S. comply with several new regulations by the end of 2016
  - ð The first rule was proposed last week
- Coordinated industry response
- Increased political pressure, especially at state levels, e.g., siting, certification, rate recovery
- Southern Company (Vogtle) and SCANA (Virgil C. Summer) preceding ï a fig leaf for everyone else
  - ð Dec 2011: NRC approves AP1000 reactor designs, clearing the path for expansion at both facilities
  - ð Feb 2012: NRC approves the issuance of the Combined Construction and Operating License (COL) for Vogtle units 3 and 4, the first such license ever approved for a U.S. nuclear plant
  - ð 10- to 12-year build cycle means next decade at best before nuclear is a material add to supply
- Reduces the chances for a grand bargain in D.C., i.e., comprehensive federal legislation encompassing a clean energy standard, including renewables, energy efficiency, and support for new nuclear
- A contrarian viewð could this be good, long term, for nuclear new build?

The problems are political (Fukushima) and economic (cheap shale gas and low power prices)

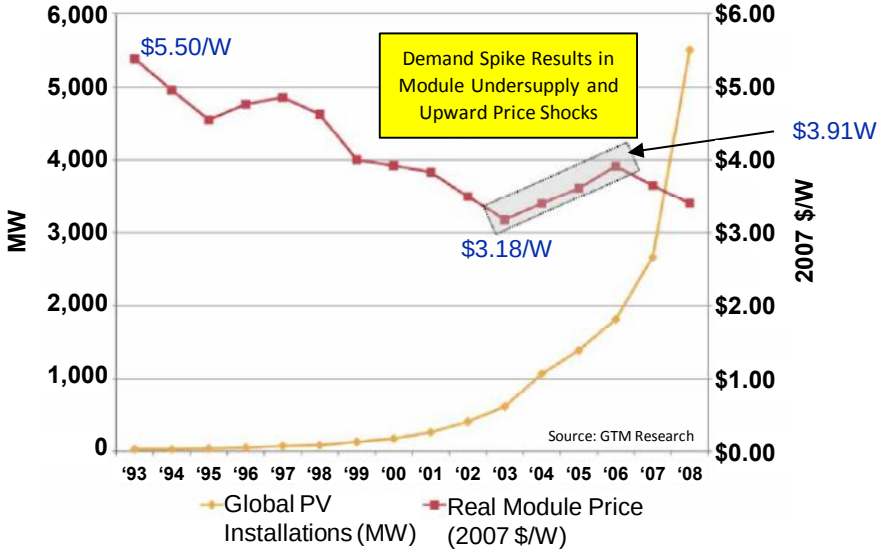
Sources: NRC, SNL

Renewables – Game Changer or Window Dressing?

Annual and Cumulative Wind Generation Capacity (MWs) vs. U.S. Production Tax Credit



Real Module Prices and Annual Global PV Installations (1993–2008)



- Renewables continue to growð NERC predicts a 3% increase in renewable on-peak capacity from 2011 to 2021, primarily from wind and solar
- Clean energy investments continue to increase, despite economic uncertainty and PR problems like Solyndra
  - ð Worldwide totaled $260B in 2011, up 5% from 2010
  - ð Investment since 2004 has grown at 26% CAGR
- Cleantech investment expected to grow, but headwinds remain: European financial crisis, overcapacity, and possible PTC expiry by 2013
- Variability and current lack of cost effective storage solutions, means neither solar nor wind has the ability to supply day-to-day base load electricity. Systems will rely heavily on fossil solutions to compensate for reliability

Sources: SNL Financial; DOE Berkeley Natð Laboratory; DSIRE.org; Greenbiz.com; Ernst & Young; National Venture Capital Association; Bloomberg New Energy Finance; GTM Research, The United States PV Market Through 2013: Project Economics, Policy, Demand and Strategy (Dec. 2009), NERC 2011 Long Term Reliability Assessment

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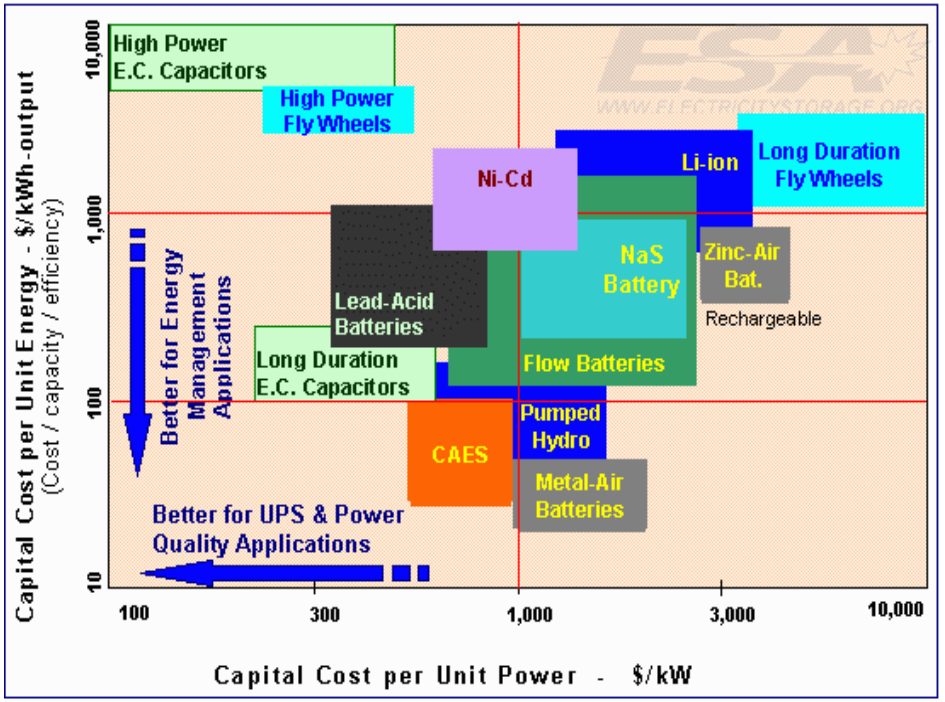
Distributed Resources and Energy Storage – Sensible or Speculative?

Installed Costs Remain High

Capital Costs of Selected Distributed Generation Technologies ($/kW)	
IC Engine	$300ï $800
Combustion Turbine	$300ï $1,000
Microturbine	$700ï $1,100
Wind Turbine	$800ï $3,500
Photovoltaic	$4,500ï $6,000
Fuel Cell	$3,500ï $10,000
Stirling Engine	$2,000ï $50,000

Cost of Electric Storage Remains High as Well



- Increasing focus on on-site renewables (solar PV) and emerging storage applications
- Barriers: price signals, siting, viability of technology, etc.
- Key issues:
  - With technology advancements and cost improvements, will distributed energy resources be a disruptive or sustaining technology?
  - Is distributed generation on equal footing with supply?
  - Ownership models: utility vs. third-party?
  - Rates and tariff design: who pays for infrastructure?

Sources: California Energy Commission; Federal Energy Management Program; Dept. of Energy; Electricity Storage Association; Claytonchristensen.com; ScottMadden analysis

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Natural Gas – Panacea or Pandora's Box?

Good News—Abundant, cleaner, and cheap (for now)

- Natural gas prices are not projected to return to pre-recession levels in the near to intermediate term
- Some contrarians, however, posit $6/MMBTU natural gas by 2015

However, demand may pull up prices, and impact of worldwide demand creates uncertainty

- Slow increase in medium term industrial gas demand, tempered by the sluggish U.S. economy
- Short-term gas demand from power generation is projected to increase, but levels off longer term (~10 years)
- More Canadian gas, now displaced by U.S. shale gas, may go to Asia
- Will U.S. exports cause domestic prices to swell?

Other unknowns also exist

- EPA FY2013 budget calls for tripling research on hydraulic fracturing
- Unknowns associated with growing interdependency of gas and electric industries

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

Selected 2012 Gas Price Forecasts ($/MMBTU)	
First Energy Capital	$5.15
Deutsche Bank	4.90
UBS	4.40
NGW** Scorecard Avg.	4.30
Raymond James	4.00
Petral Consulting	3.90

We have been through a gas boom and bust cycle before

Sources: Industry news; EIA; IEA; FERC; SNL Financial; *Natural Gas Week; Washington Times*

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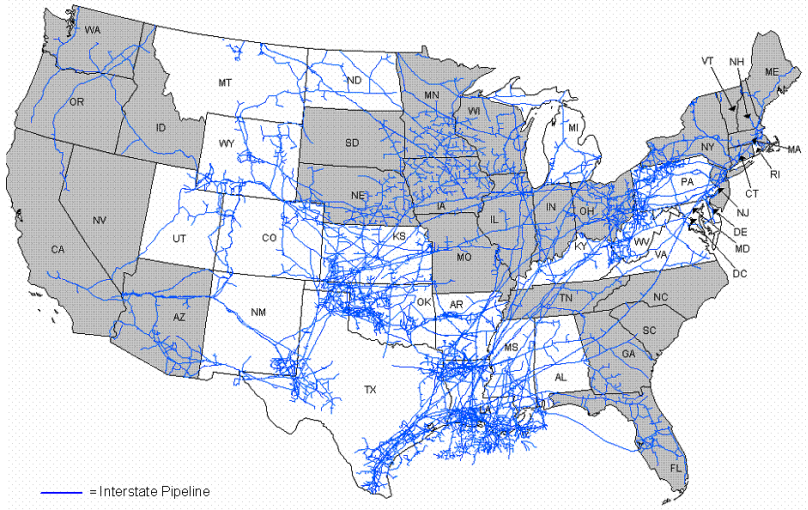
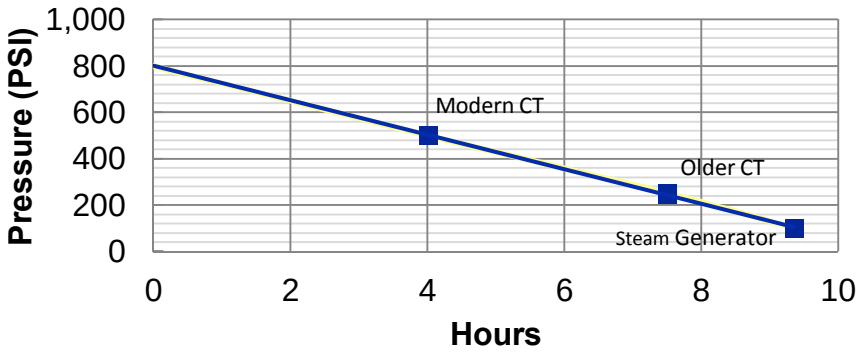
Natural Gas – Panacea or Pandora's Box? (Cont'd)

Interstate Natural Gas Pipelines (as of Year-End 2009)



Time for 500 MW Unit to Exhaust Line Pack (36" Line @ 800 PSI)



- Gas-power interdependence is back on the front burner
  - EPA regulations, cheap shale gas, and increasing renewables penetration lead swings to gas generation
  - FERC had looked at this in the mid-2000s, as post-merchant, pre-Katrina bubble led to a significant increase in the ratio of gas to total generation
- Recent weather events (Texas, Southwest) have refocused attention on increased year-round power sector gas demand
- Emerging pipeline adequacy and operations concerns
  - Capacity constraints
  - Scheduling differences
  - Pipeline pressure and line pack
  - Flow patterns
  - Curtailment

Sources: EIA; SNL Financial; NERC

More gas fired generation will require additional pipeline infrastructure, increased coordination with pipeline operators, and developing operational strategies to minimize fuel delivery issues

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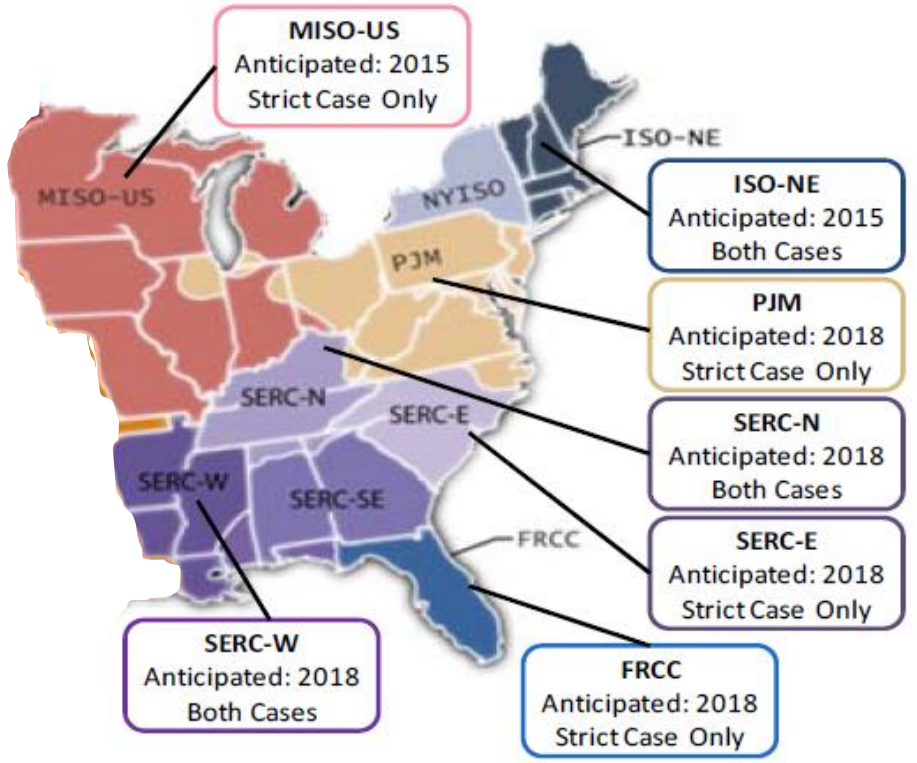
Planning Reserve Margins – Feast or Famine?

- Wholesale power prices have two primary drivers
  - Fuel prices
  - Reserve margins
- North American Electric Reliability Corp. generic, assumption-based estimates of reserve margins diverge

Without EPA Regulation	With EPA Regulation
Ample in most regions until 2019	Levels associated with rolling blackouts and spiking prices in some regions by 2018

- Risk of precipitous decline exacerbated by estimated lead times for develop-build
  - Nuclear: 10ï 12 years
  - Coal: 5ï 7 years
  - Wind: 3 years
  - Gas: 2 (CT) to 3+(CC) years
  - Transmission: 10 years

Potential Resource Adequacy Trouble Spots: Year When Planning Reserve Margins Fall Below NERC Reference Margin Level



NERC predicts that most Eastern Interconnection regions may see Planning Reserve Margin issues between 2015—2018

Source: NERC 2011 Long-Term Reliability Assessment, Fig. 57 (Nov. 2011)

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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, contractsð 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

Case Study – A Tale of Two Retirements

Cromby Generation Station

- Unit 1 – 144 MW (coal)
- Unit 2 – 201 MW (natural gas or fuel oil)
- Located 25 miles NW of Philadelphia International Airport

Eddystone Generation Station

- Total 1,114MW (including coal, natural gas, and oil units)
- Unit 1 and 2 – 294 MW each (coal)
- Located just south of Philadelphia International Airport

Sequence of Events	
Dec 2009	◆ Exelon informs PJM that it plans to retire Cromby Units 1 and 2 and Eddystone Units 1 and 2, effective May 2011
Feb 2010	◆ PJM indicates that in order to complete transmission upgrades required to maintain system reliability, Cromby Unit 2 and Eddystone Unit 2 will need to run beyond proposed retirement date
June 2010	◆ FERC grants Reliability Must Run (RMR) status to Cromby Unit 2 until May 2012 and Eddystone Unit 2 until Dec 2013
Dec 2011	◆ Cromby Unit 2 retired
May 2012	◆ Eddystone Unit 2 planned for retirement

From announcement to retirement, grid reliability upgrades required 2 to 2.5 years to complete

Sources: "Clean in Competitive Markets", Exelon EEI Nov. 2010; BusinessWire, Oct 18, 2011

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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 explicitð and challenge them!
  - Consider more than one state of the world

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