BEG CEE CENTER FOR ENERGY ECONOMICS



20th Annual Meeting

December 9-10, 2015 Houston, Texas

Let's Make A Deal!

- Welcome and safety
- Agenda and meeting rules
  - Meeting record
- "What Keeps Me Up at Night" submissions

CEE 2015 in Review

GOALS	RESULTS/OUTPUTS
Launch global gas deep dive	• China, India cases; China presented at WGC • Combined report in progress • LNG supply companion paper • ***Next up?*** Aggregated small markets? • Meanwhile, Asia/Europe gas for MEPR
Upstream – continue benchmarking, quality improvements	• U.S. producer snapshots, "look ahead" report in progress • Tax considerations (state level) still in development • NOCs/sovereigns, snapshots; "backcast" to 2013 paper and low oil price considerations
Midstream – short-mid term tracking, longer term views	• Industrial demand, eye to downstream monetization • LTO growth and "lightening" slate, USCG *Proceedings*

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CEE 2015 in Review, cont.

GOALS	RESULTS/OUTPUTS
Electric power – continuous improvements and expanded scope	• Sustain AURORAxmp modeling • Coal fleet retirements, environmental rules, renewables, gas share • Nuclear energy – technology, economics, retirements, system impacts; ***Roundtable III January 6, 2016*** • UTEI full cost of electricity – LCOE, LACE, system costs • Price formation and uplift payments – LMP, ELMP, others
Energy storage and critical mineral resources	• Lithium and other critical minerals value chain economics, snapshots & forthcoming report • Resource access, commercial frameworks
State/ENR invitation for Government of Mexico	• ***Launched:*** technical assistance for upstream within context of overall sectoral integrity

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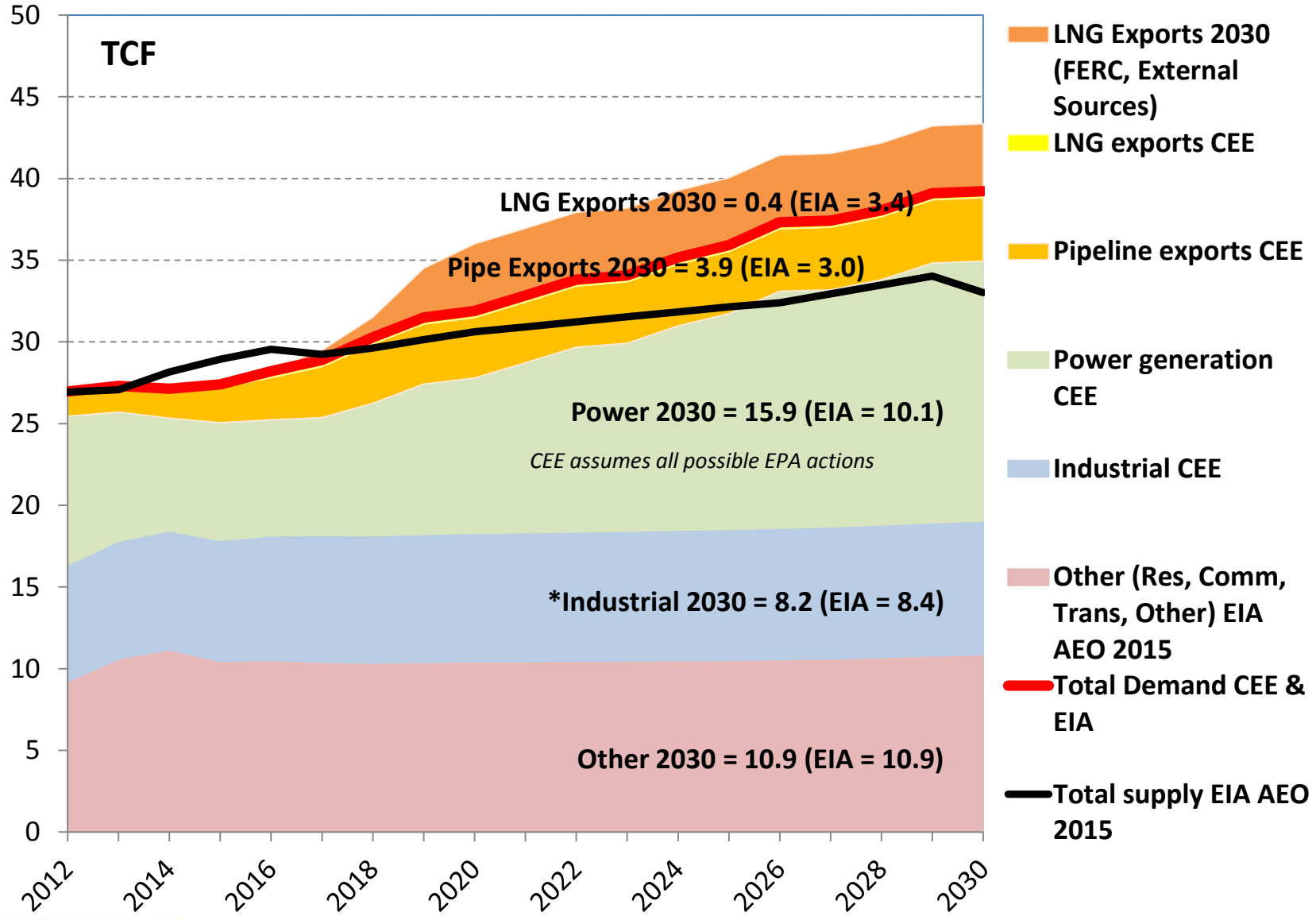
Gas: A Strong "Demand Stack" Scenario



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*CEE analysis and modeling; *CEE outlook does not include growth in EIA industrial baseload; EIA AEO 2015 (reference case)*

2015 – Wheeling and Dealing Through Cycles

- Business models and economics – what drives what, when, how, with what outcomes
- BEG/CEE analytics and modeling, mid-long term views
  - –Accessible to public, deeper dives, deeper considerations for state of the industries and commercial frameworks
- External forces and disruptions
  - –Environment and public perceptions/reactions
- ***CEE RESEARCH REFINEMENTS FOR 2016***

Keynote – Peter Zeihan

BIG MOVING PARTS – DO ACCIDENTS "HAPPEN"?

Upstream Part I

UNCONVENTIONALLY CONVENTIONAL

Humble Pie

"I Was Like, Oh My God"*, Did I Really *Say* That? (August 2006)

Probability	Scenario
Low	Oil at $90, gas at $15: oil price pulls other costs, inflation, gas demand fundamentals
Medium (coin flip)	Oil at $48, gas at $8.28: approaching equilibrium and parity?
Higher	**Oil $45-60, gas at $3-5: diverging fundamentals**

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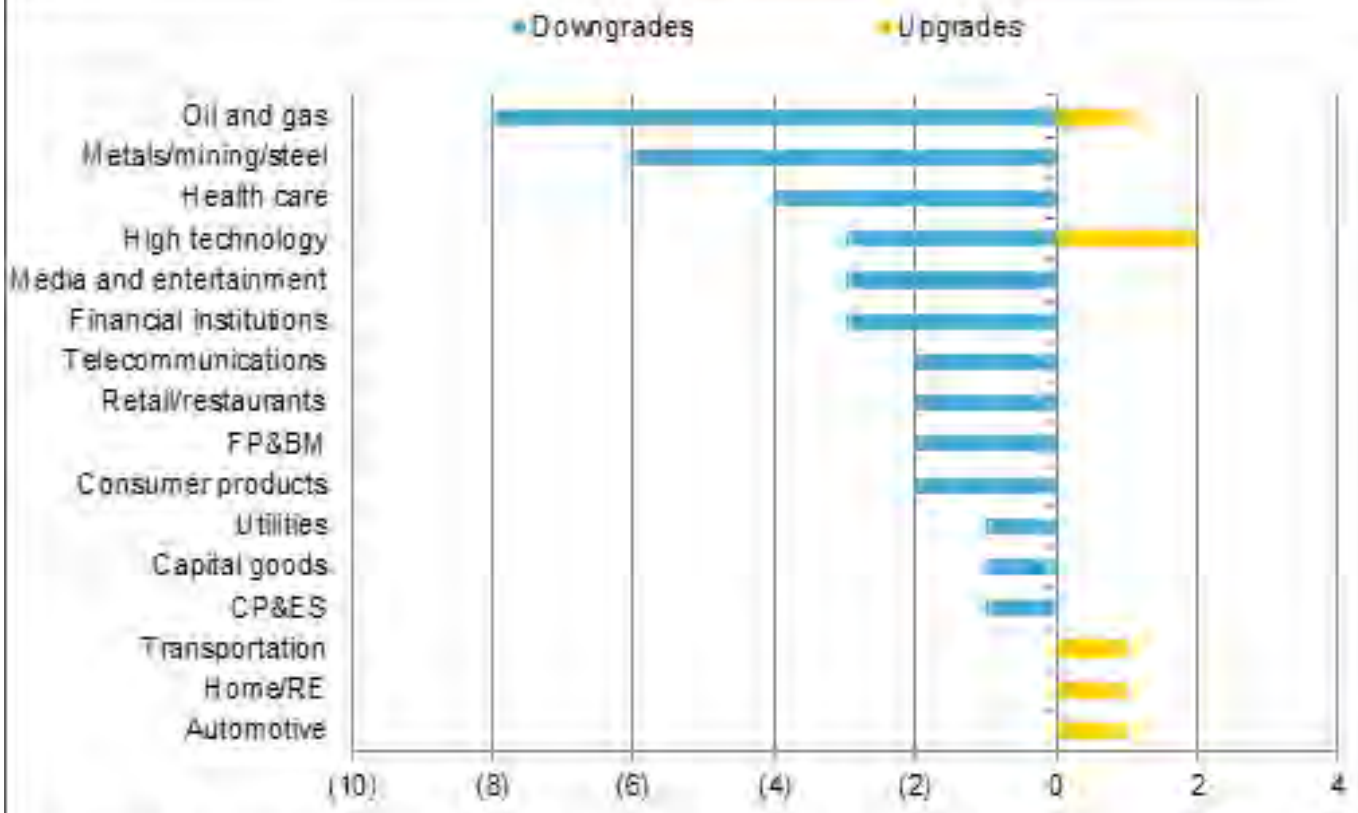
** Tribute to Billy Collins*

U.S. Speculative-Grade Corporate Rating Actions By Sector In November

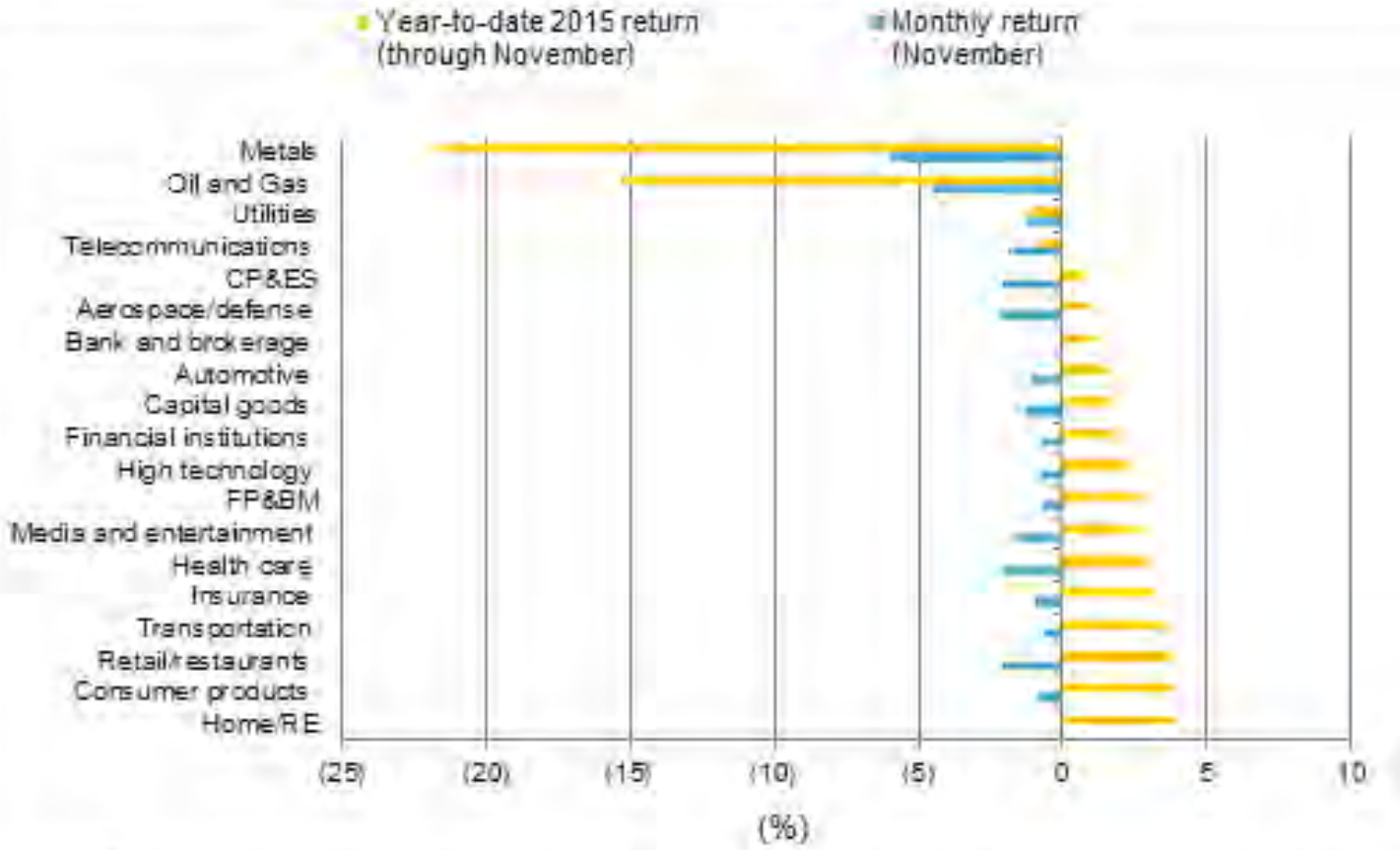


Home/RE--Homebuilders/real estate companies. CP&ES--Chemicals, packaging, and environmental services. FP&BM--Forest products and building materials. Financial institutions include banks, brokerage companies, finance companies, mortgage institutions, and savings and loans. Rating changes exclude entities with no rated debt. Downgrades are shown as a negative number. Data as of Nov. 30, 2015.
Source: Standard & Poor's Global Fixed Income Research.

Subsector Distribution Of Weakest Links By Number Of Issuers

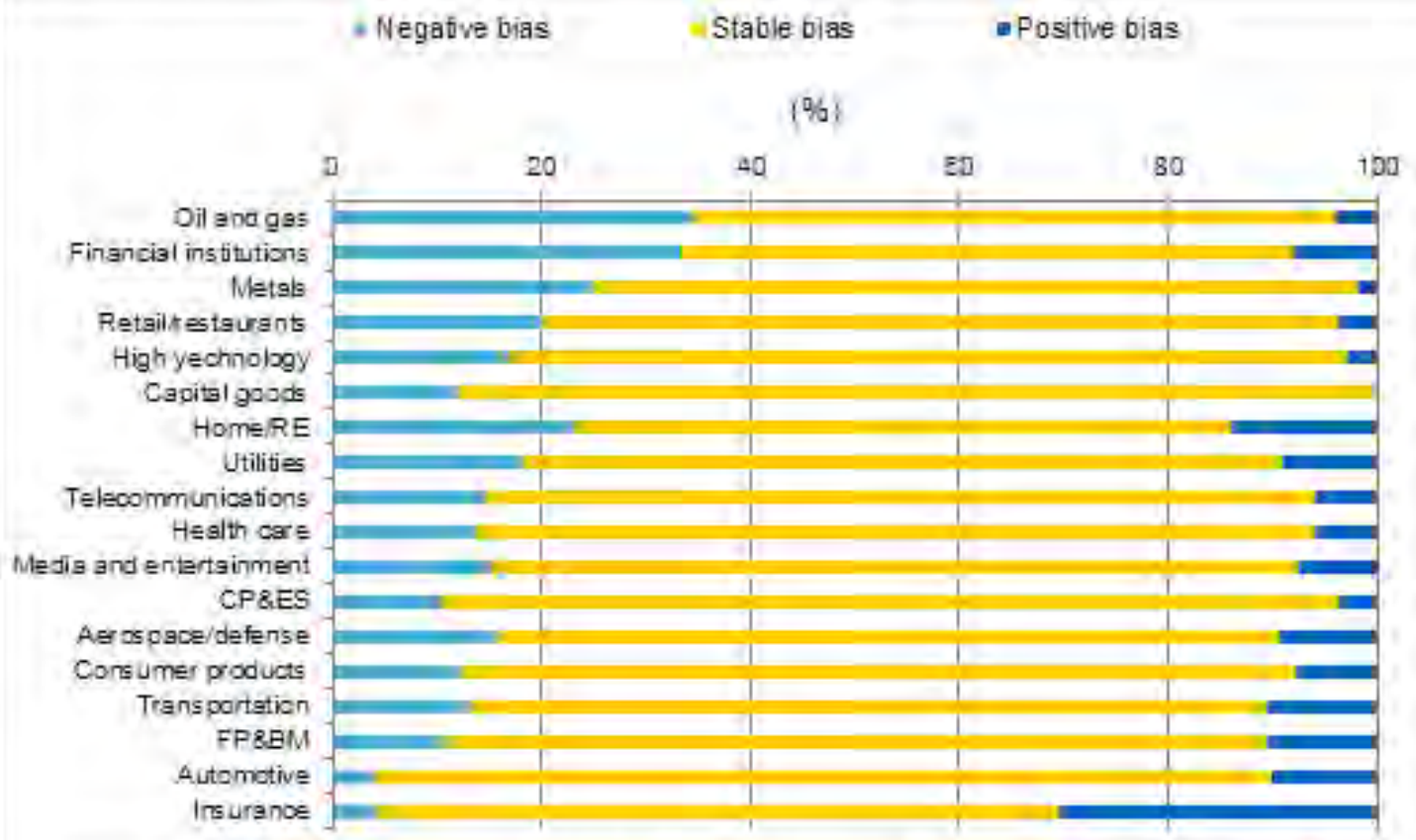
Home/RE--Homebuilders/real estate companies. FP&BM--Forest products and building materials. CP&ES--Chemicals, packaging, and environmental services. Data as of Nov. 19, 2015. Source: Standard & Poor's Global Fixed Income Research.

Speculative-Grade Corporate Composite Total Returns By Sector

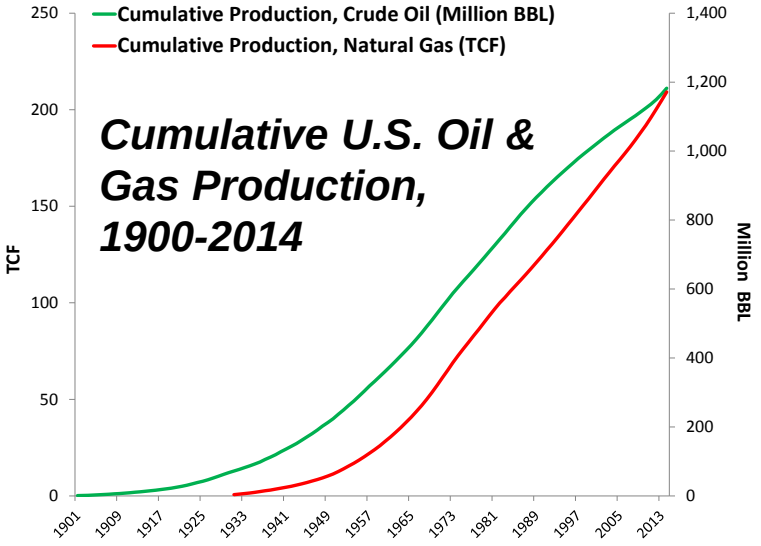


Home/RE--Homebuilders/real estate companies. FP&BM--Forest products and building materials. CP&ES--Chemicals, packaging, and environmental services. Note: total returns for U.S. corporate speculative-grade bonds, calculated as a composite. Data as of Nov. 30, 2015. Source: Standard & Poor's Global Fixed Income Research.

U.S. Speculative-Grade Rating Bias By Sector (as of 11/30/2015)



FP&BM--Forest products and building materials. CP&ES--Chemicals, packaging, and environmental services. Home/RE--Homebuilders/real estate companies. Financial institutions include banks, brokerage companies, finance companies, and savings and loans. Source: Standard & Poor's Global Fixed Income Research.



Oil & Gas Technology Pathway

- *Arctic?*
- *Hydrates?*
- *Multistage hydraulic fracturing*
- *4-d seismic*
- *3-d seismic, horizontal drilling, measurement while drilling*
- *Directional drilling; pipeline trenching and welding, compression, pressure control, metering*
- *Long-line pipeline transmission*
- *Advances in drilling, early seismic, shallow offshore E&P*
- *Oil discovered at Spindletop (Texas), 1901*
- *Oil discovered in Titusville, Pennsylvania, 1859; natural gas replaces town gas in U.S., 1870s*

Offshore water depths (feet):

0-25 | 250 | 1,000 | 5,000 | 10,000+

Porosity, permeability:

Conventional | Unconventional | "Nano"

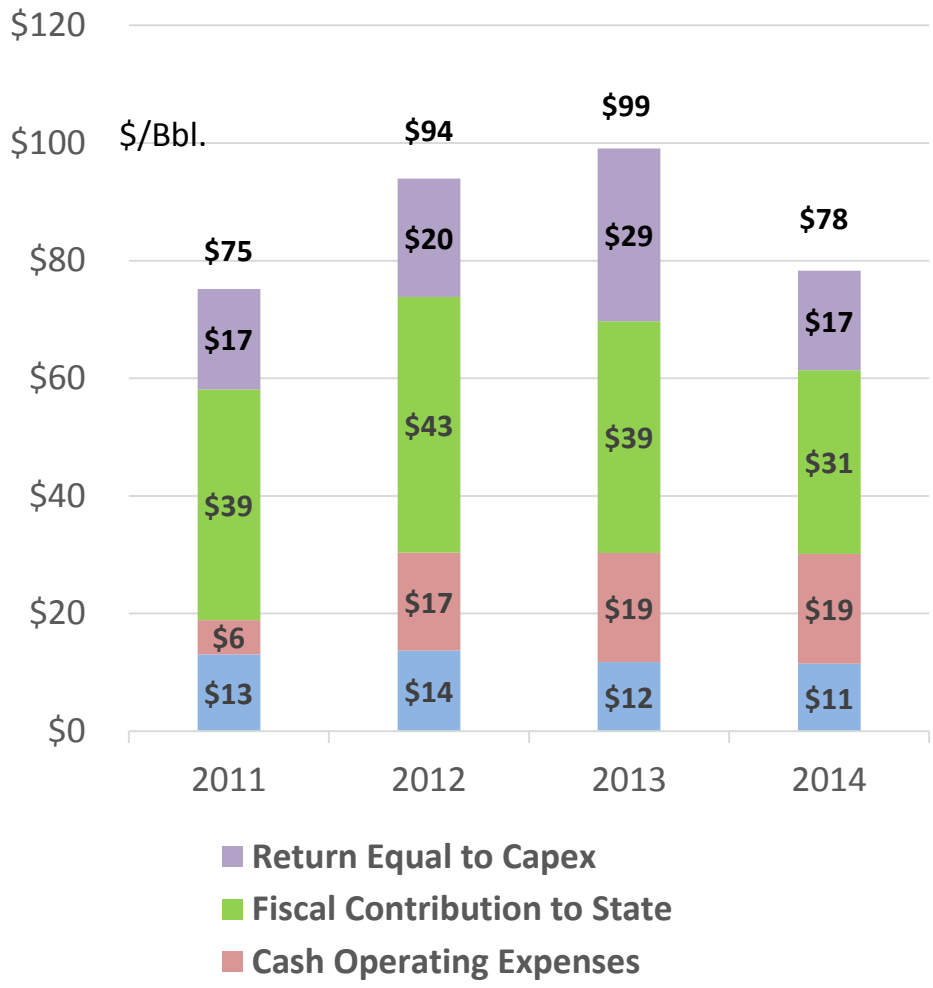
IT Pathway:

Slide Rule | Mainframes | Minis/Micros/Workstations/Networks "Standalone" | Data Integration

1850 1900 1930 1940 1950 1960 1970 1980 1990 2000

Not to scale

NOC Upstream Costs and Leverage



LTD/Equity %	2013	2014	Moody's Rating
Investment Grade			
Statoil	46%	54%	Aa2-S
CNOOC	24%	28%	Aa3-S
PetroChina	24%	28%	Aa3-S
Sinopec	28%	28%	Aa3-S
Petronas	11%	9%	A1-S
Pemex	Negative Equity	Negative Equity	Baa1-S
Ecopetrol	30%	49%	Baa2-S
ONGC	7%	27%	Baa2-S
Speculative Grade			
Rosneft	53%	76%	Ba1-N
Petrobras	71%	103%	Ba2-S
PdVSA	53%	53%	Caa3-N
Simple Average	**35%**	**46%**	

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Day One Luncheon Keynote – Mark Houser

ENERGY OPPORTUNITIES

Upstream Part II

NAVIGATING THE MIDSTREAM RAPIDS

What We Said in June 2013

- MLPs in the midstream are abandoning less profitable basins with more dry or non-associated gas and shifting their production/capital to basins with more profitable hydrocarbons such oil and liquids
- Those shale plays richer in crude oil and liquids such as Eagle Ford, Marcellus, and Permian will benefit from this shift

Conclusions/Concerns from June 2013 Meeting

1. Vicious cycle: need more DCF to pay unit holders requiring more capital to build or buy assets that create more DCF.
2. Assets can become overvalued due to increased competition among MLPs to increase DCF
3. **Oil and NGL prices could weaken with increased production thereby pressuring DCF of the MLPs**?
4. **Could credit metrics weaken or MLPs become overleveraged in quest for DCF?**
5. Is a Bubble forming?

Implications for CEE research

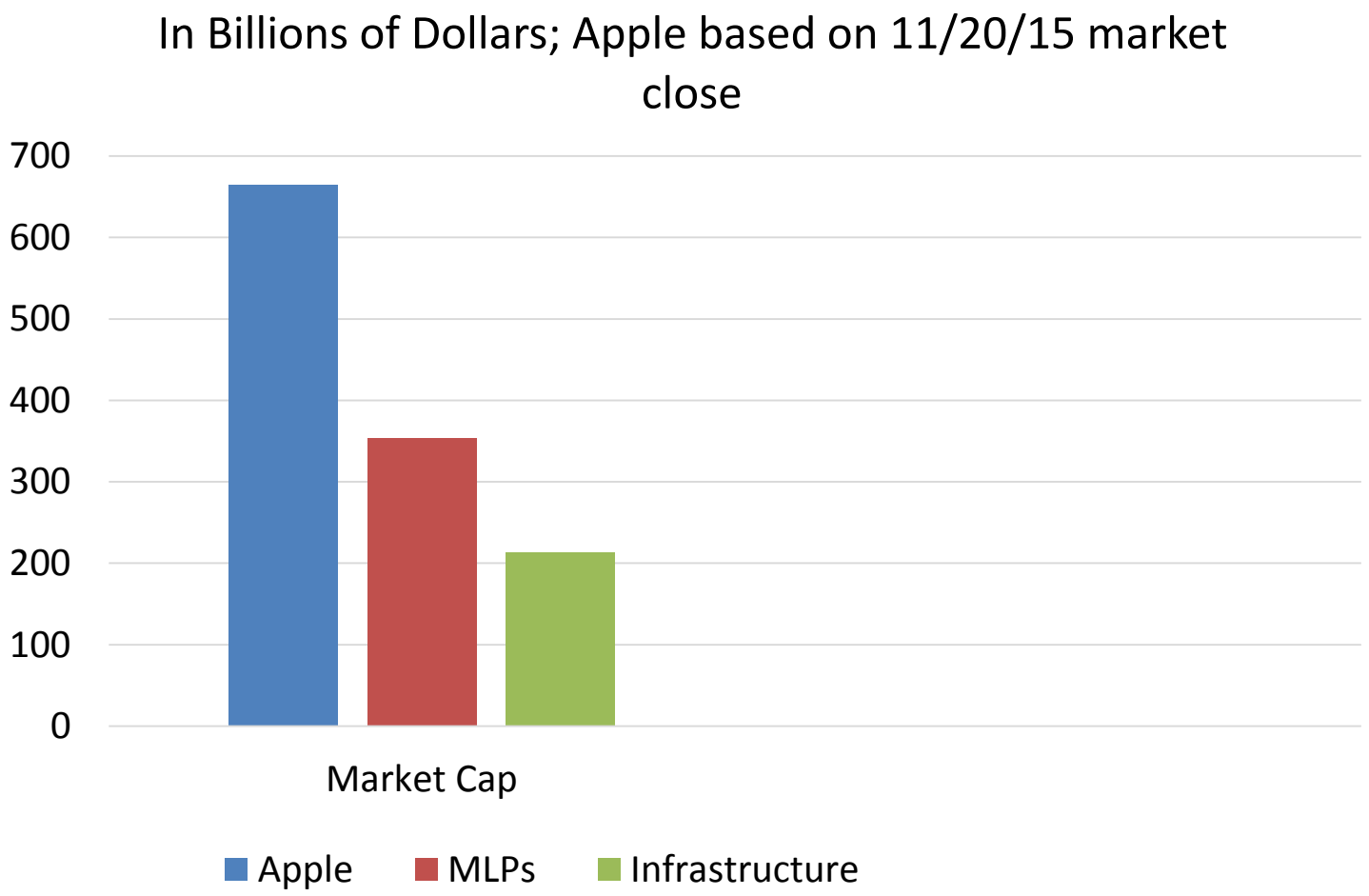
Teeing Up the Issues

- In what way Is Midstream different then the rest of the petroleum industry? Regulatory? Economics? Business/Financial model?
- Are there drivers or indicators that are different for Midstream than for other oil patch industries?
- Anything happening today in the Midstream that is not happening to other petroleum industry sectors?
- Is there likely to be any actionable results from further Midstream study? For example:
  - Are producers and customers being well served by the current business/financial structure?
  - Does the Midstream business model fit the underlying economics?
  - Is there a more efficient business model?
  - Is the current round of consolidation leading to too much market power?
  - Where is FERC on changes in Midstream?
  - Implications of current trends in the U.S. petroleum industry?
  - What changes are needed?

Midstream – What's the economic Rationale?

1. Majors vs. Independents
2. Economies of Scale
3. Appropriate risk-reward ratio between business and customer
4. Is this a competitive industry?
5. Focus on Core Competencies
6. Regulatory incentives/barriers
7. Cost of Capital
8. Financial Vehicles
9. Sources of Capital
10. Investor Risk Profiles
11. Tax incentives/Disincentives
12. Market-based rates versus Fixed ROI
13. Geographic scope
14. Others?

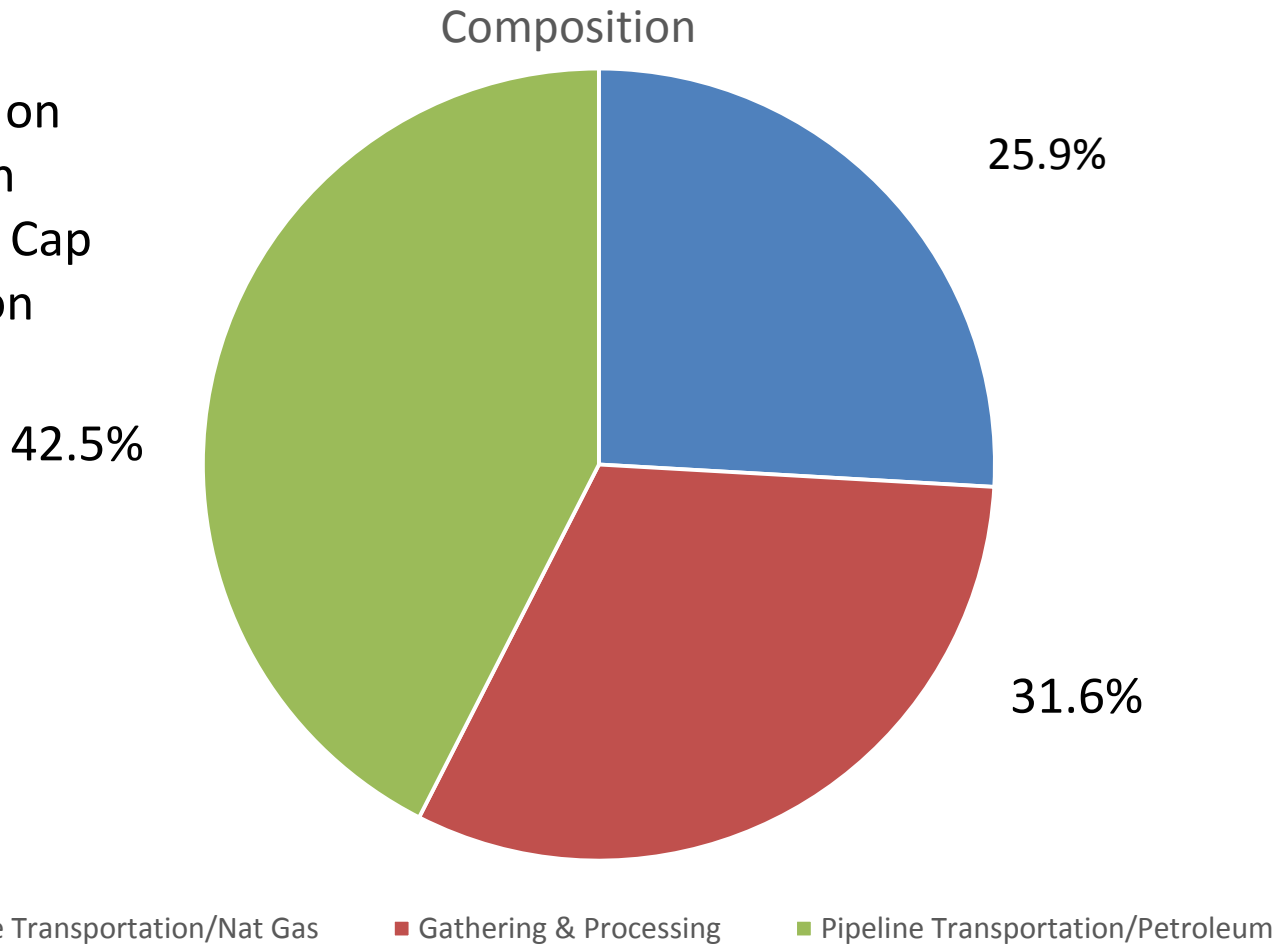
Size of the Midstream



Source: AMZI Fact Sheet

Infrastructure in the Midstream

AMZI based on 22 MLPs with total Market Cap of $213 billion



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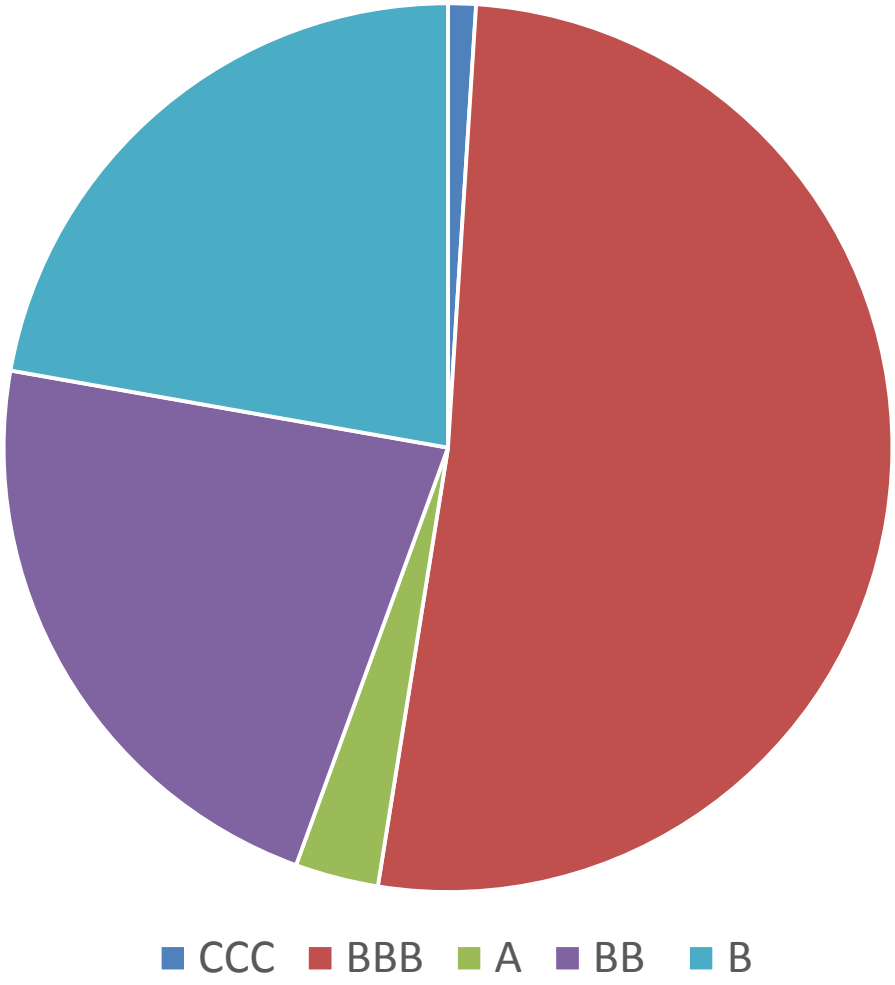
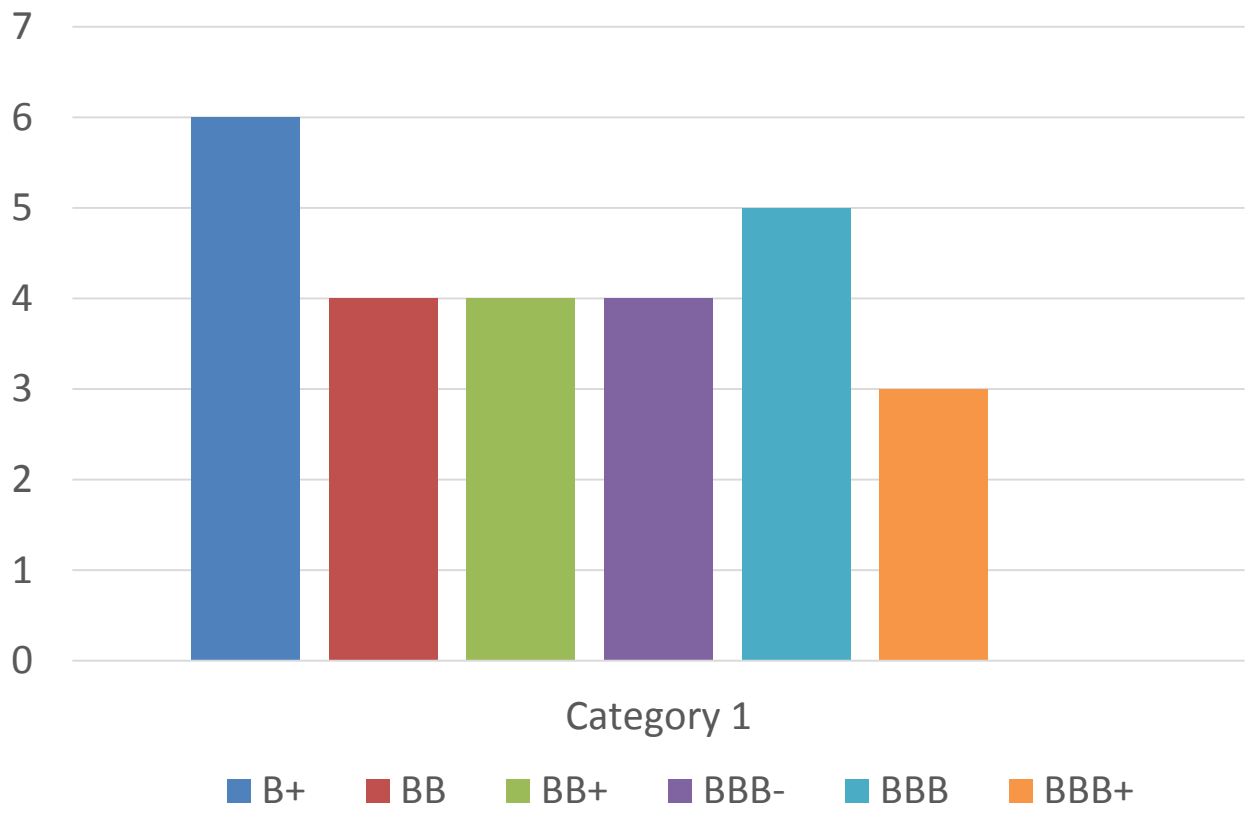
S&P ratings of Midstream



S&P Ratings of Midstream Co's



Two Notable Downgrades: DCP from BB to BB from BBB- and Enbridge from A- to BBB+

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How Bad is Bad? Financial Optics

- S&P reports 11 downgrades as of Oct, 2015 as compared to 11 for all of 2014. 13 companies are on negative watch
- DCP and Enbridge were 2 large downgrades in 2015 by S&P
- Moody's lowers midstream outlook as a result of cuts in capex by E&P companies that funded infrastructure projects
- Continued low NGL prices
- Alerian Index (ETF for MLPs) is down 30% as of Oct
- Cost of capital is increasing (e.g. KMI paying 9.75% on mandatory preferred shares)
- Unit prices of MLPs are down as investors flee the sector

How Bad is Bad?

- Proportion of defaults by E&P companies has risen to 42% in North America so far this year
- The sector leads in the weakest links (issuers Standard & Poor's rates 'B-' or lower with negative outlooks or on CreditWatch with negative implications) and is considered the sector to be among the most vulnerable to defaults in the coming months
- According to S&P, the oil and gas sector accounted for the largest number of distressed borrowers, 95 out of 270

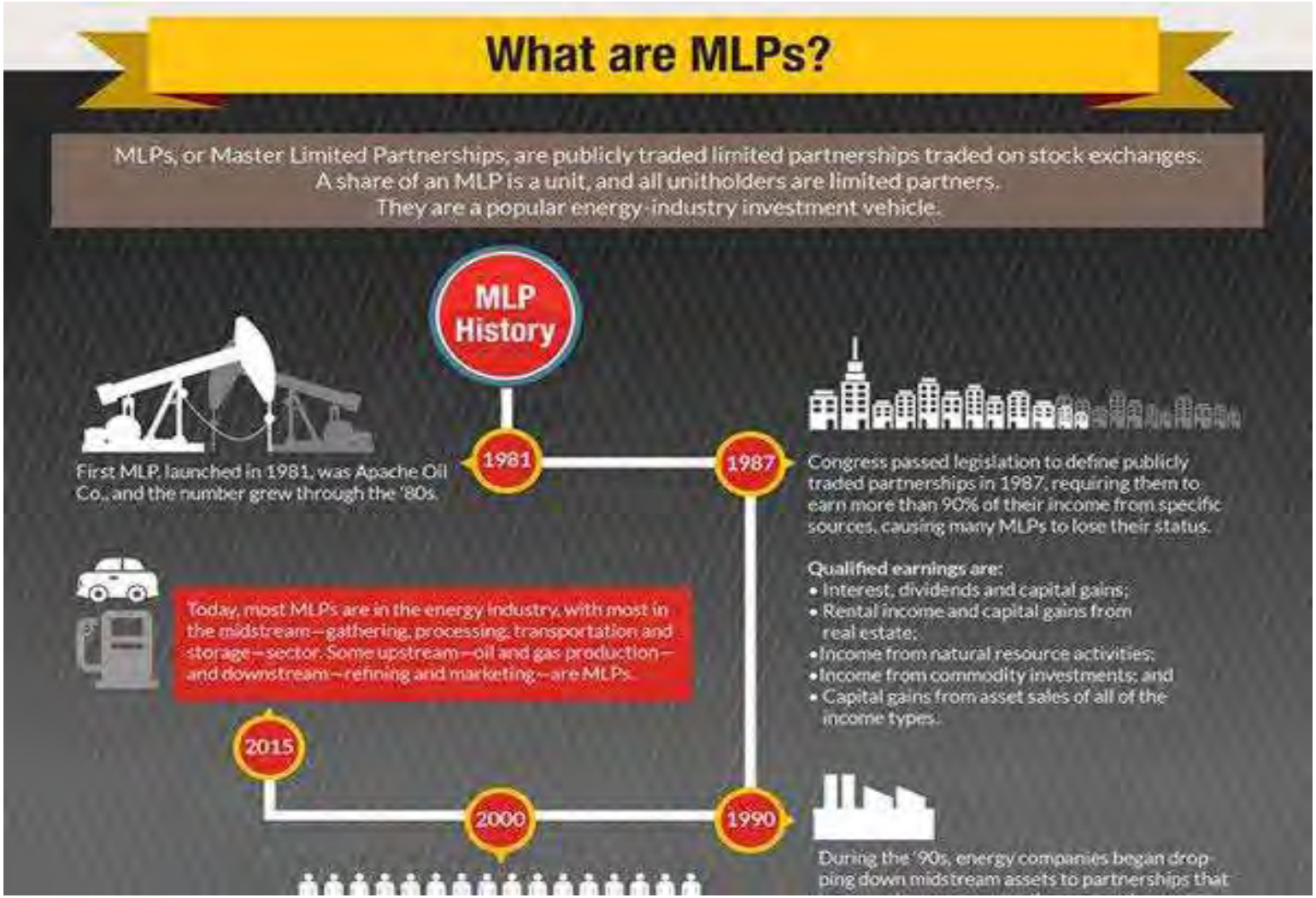
How Bad is Bad?

- Moody's analysts downgraded their outlook for global midstream on Aug 17th
- From "Positive" to "Stable"
- Project that EBITDA growth will slow to 3% to 5% in 2015 and slower growth in 2016
- Deep spending cuts in E&P have reduced midstream spending that underpinned their previous positive outlook which peaked at 15% in 2013 and 2014
- Moody's does project that Marcellus and Utica plays are still in need of additional infrastructure investment
- Gathering and Processing segments are feeling pressure of low prices
- Moody's held out possibility of further downgrade if EBITDA slows more than 5% as projected

Negative Trends for Midstream

- Lower energy prices
- Hedges are rolling off and being renewed at lower levels
- DCF (Distribution Coverage Ratio) is decreasing
- Lower production volumes are hitting their revenues
- Margins being squeezed by producers reaching for more margin (e.g. Chesapeake/Williams deal)

MLP is Dominant Business Structure in the Midstream



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MLP vs C Corps

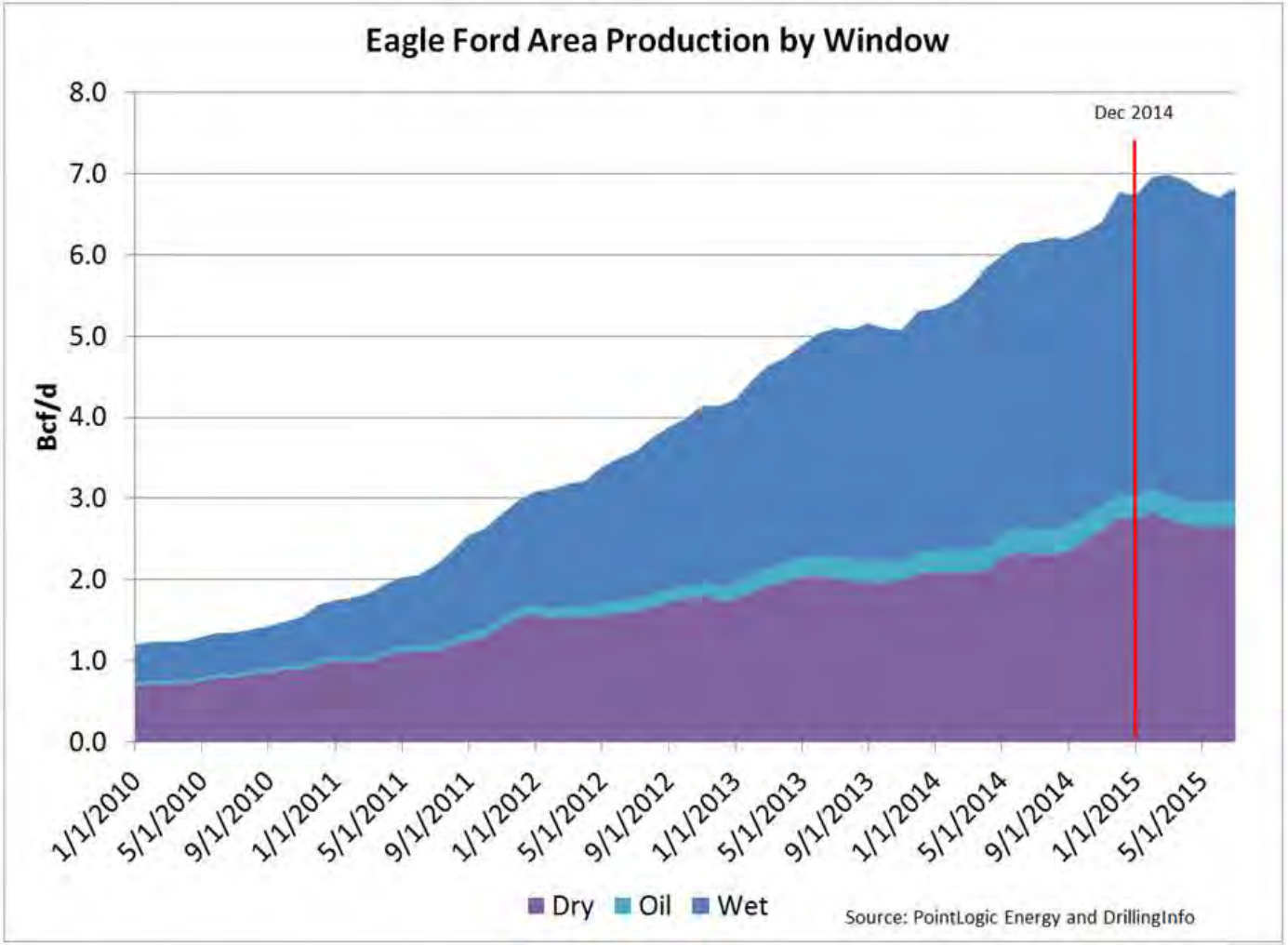
Current Financial Stress on MLPs

- One problem cited is lack of “MLP quality” assets for drop downs
- Cost of capital could limit ability to fund acquisitions or make the more expensive
- Lack of upstream development continues to limit need for infrastructure which will limit future drop downs
- More M&A as a result?

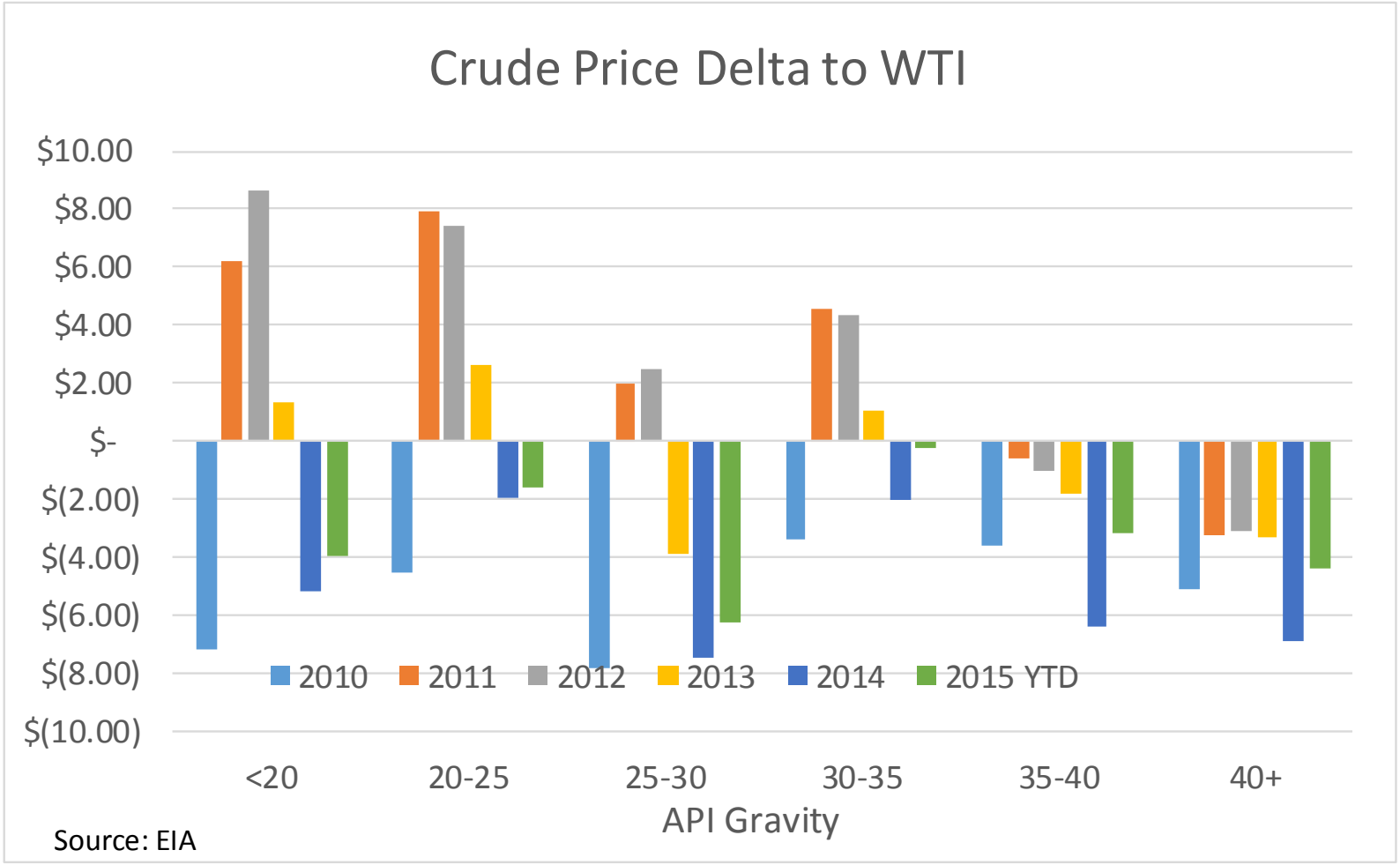
Can MLPs Survive?

- Many are already predicting the demise of the MLP. If it doesn't survive, what does this do to the energy value chain? Winners and losers?
- Will midstream start to segregate into two classes: major non-MLP companies (KMI ETE, etc) versus the smaller MLPs? Is there a comparative advantage?
- If MLPs do survive, what changes will the business model have going forward as a result of low energy prices and what impact on value chain?
- How is midstream responding to current financial stresses and what is the impact on the industry?

Will Higher Prices Reverse the Declines?

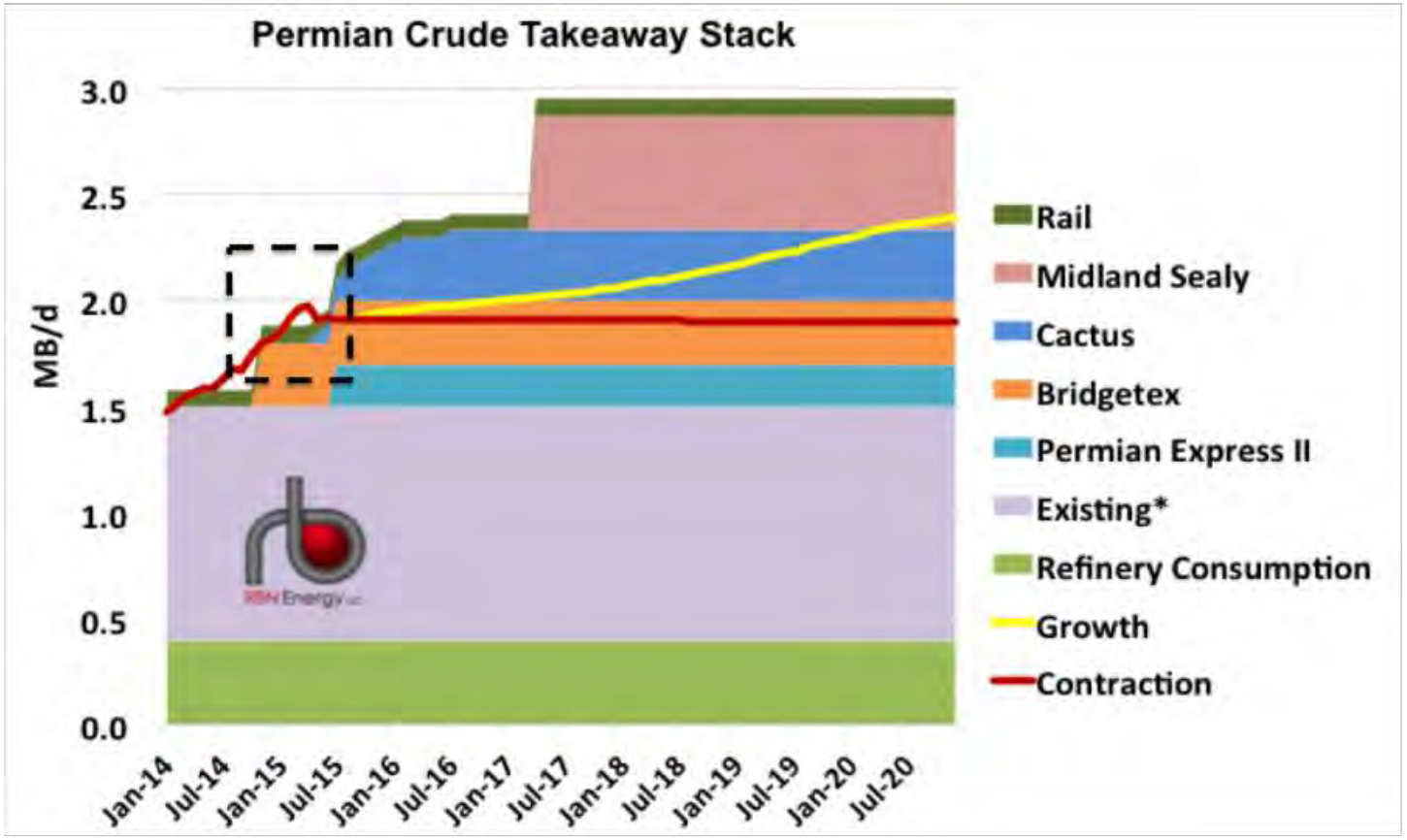


More Light Less Heavy Means?



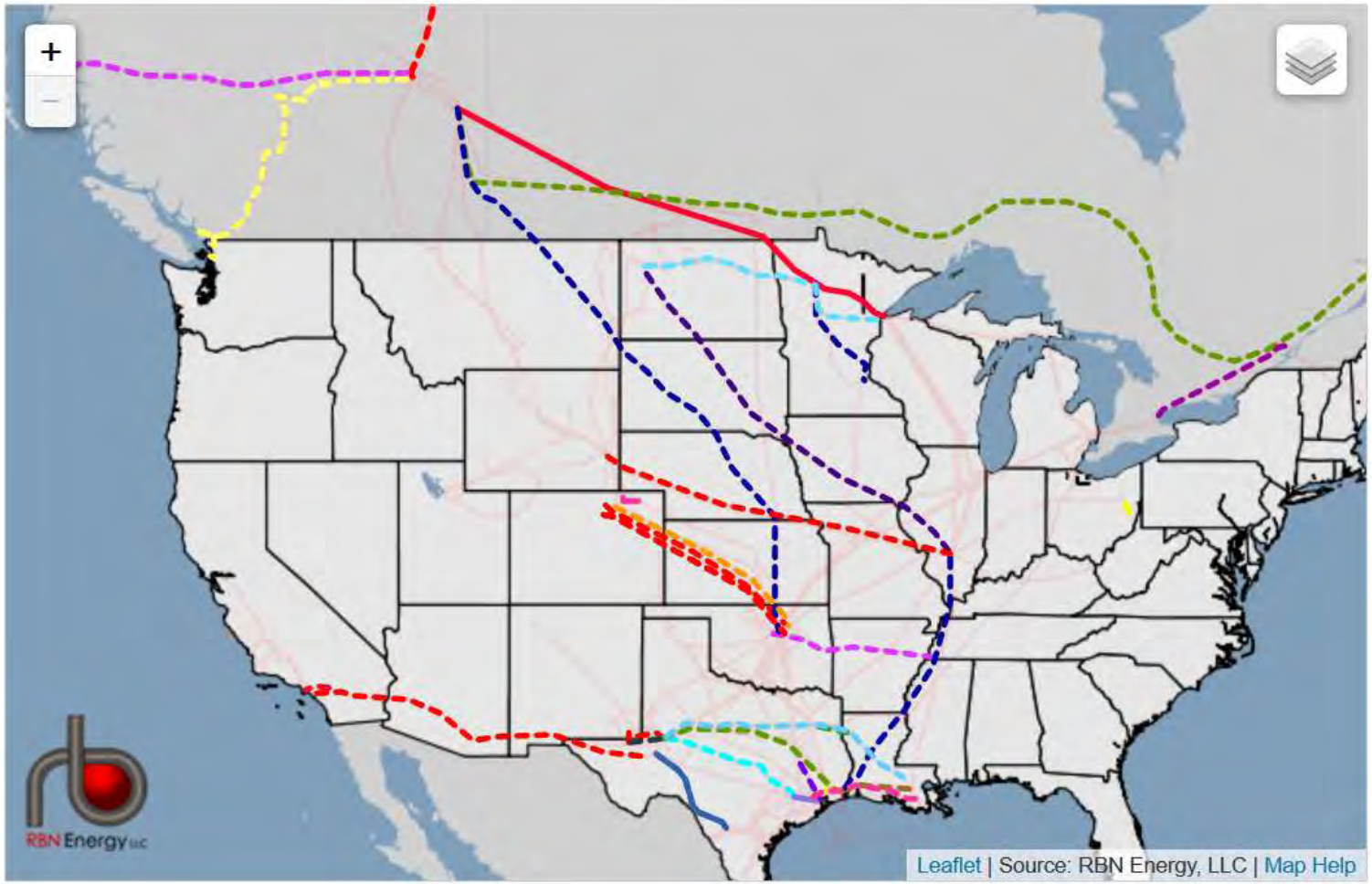
Source: EIA

Are Many Other Basins Overbuilt?

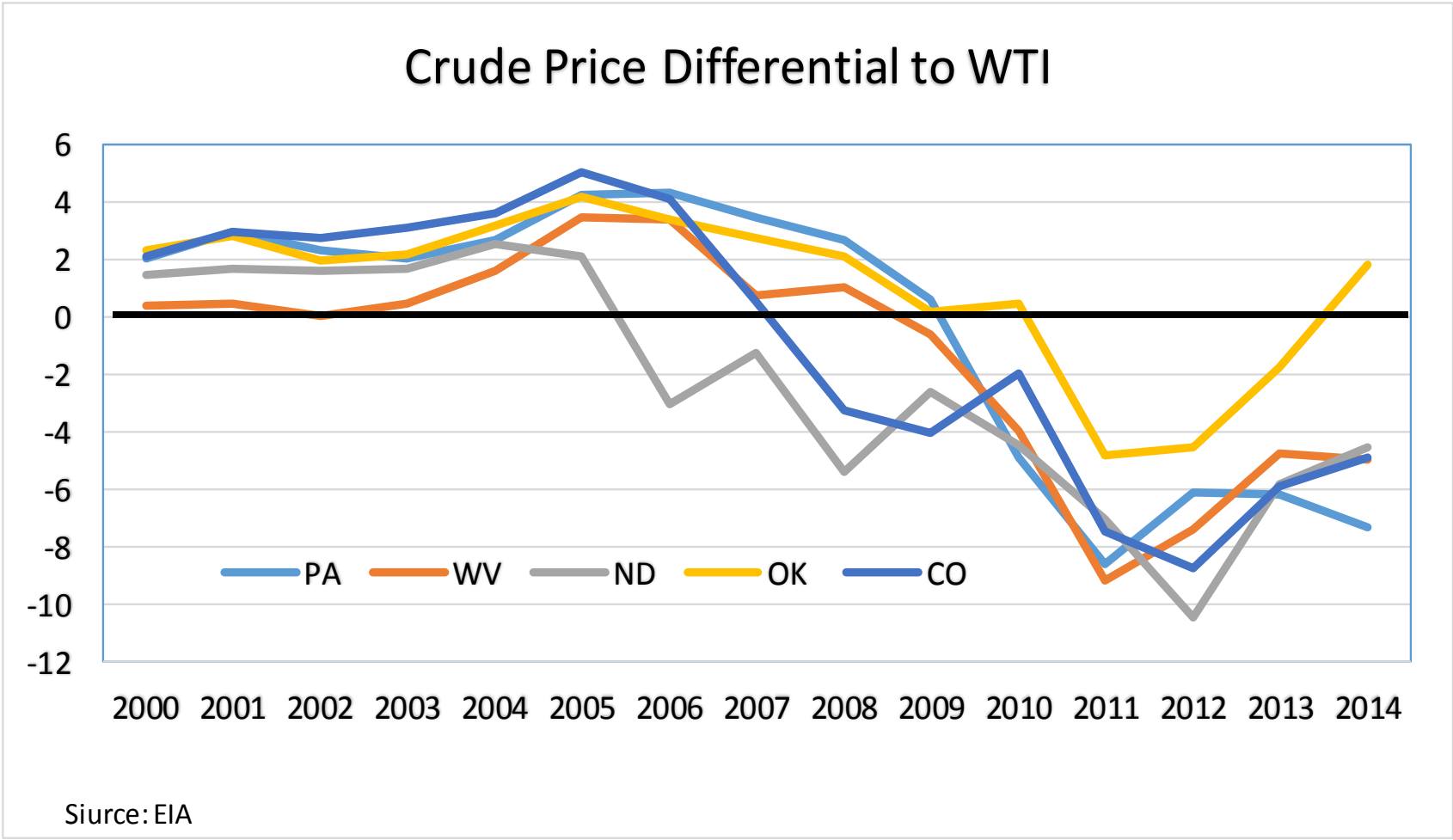


* Basin, Centurion, West Texas Gulf, Longhorn pipelines

Proposed Crude Pipelines



Did New Pipe Raise Realizations?



Siurce: EIA

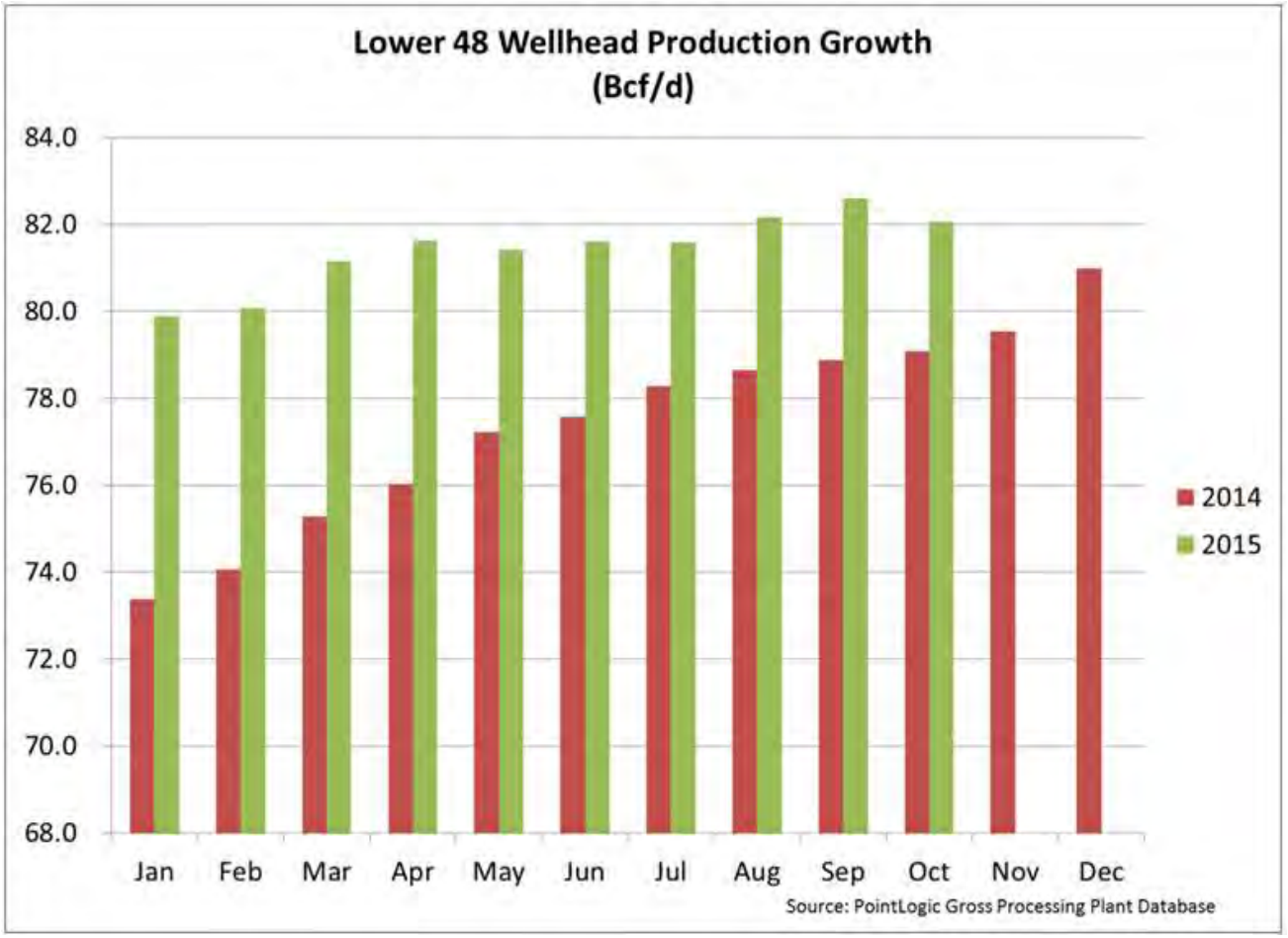
Bakken Crude Squeeze

- Region is still dependent on rail takeaway with limited pipeline capacity
- Higher cost of rail vs pipe now causing east coast refiners to move to foreign crudes instead
- Producers can't afford the discounts to move by rail and abandoning the region
- Occidental Petroleum sold its ND assets to undisclosed buyer for $600 million
- Two other Bakken players: American Eagle and Samson Resources are in bankruptcy (WSJ: 11/23/15)

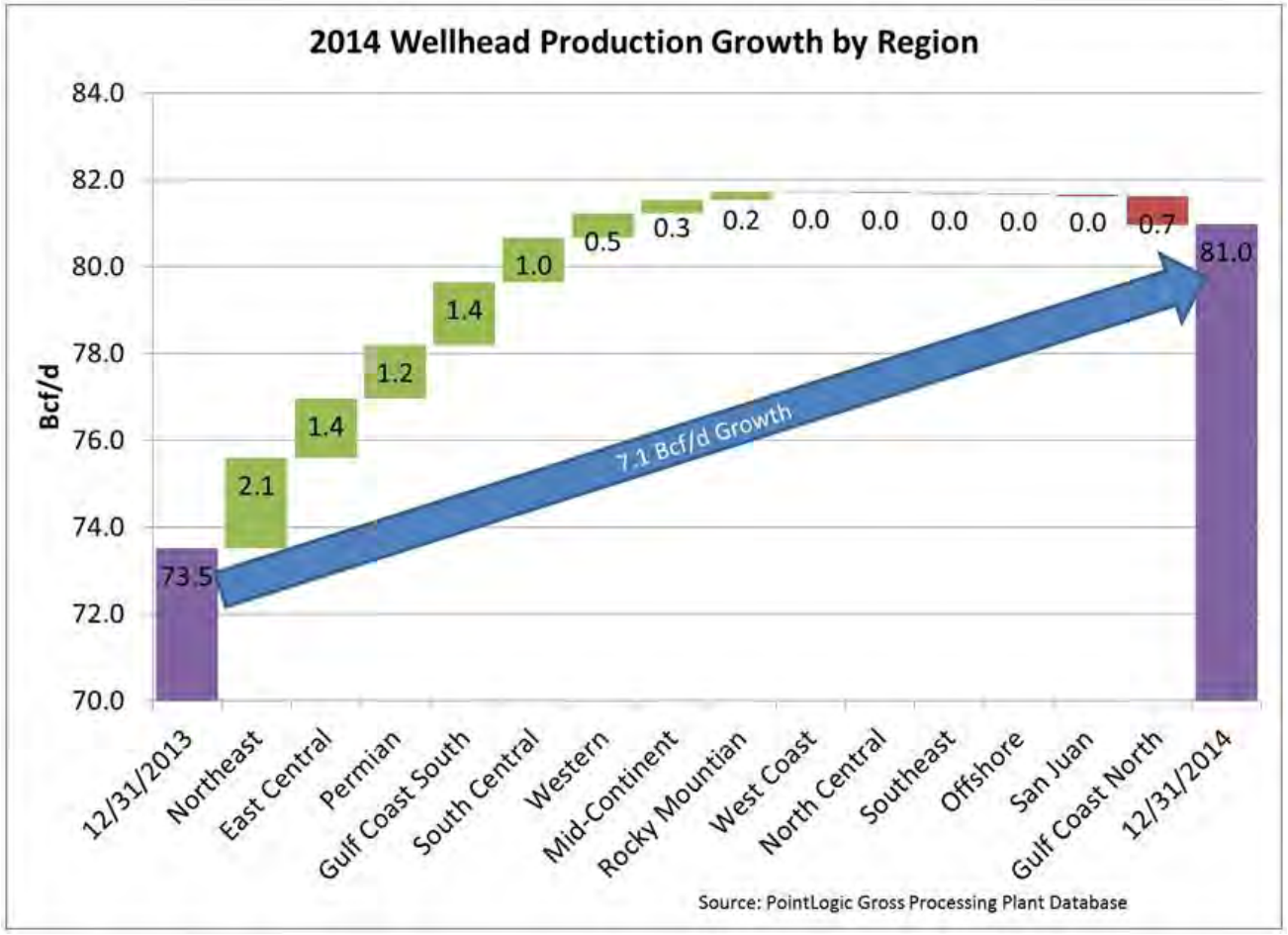
Estimated ND Rail Export Volumes

Source: ND Pipeline Authority

Gas Production: Not Much Change Since April



Will 2014 Ever Be Repeated?



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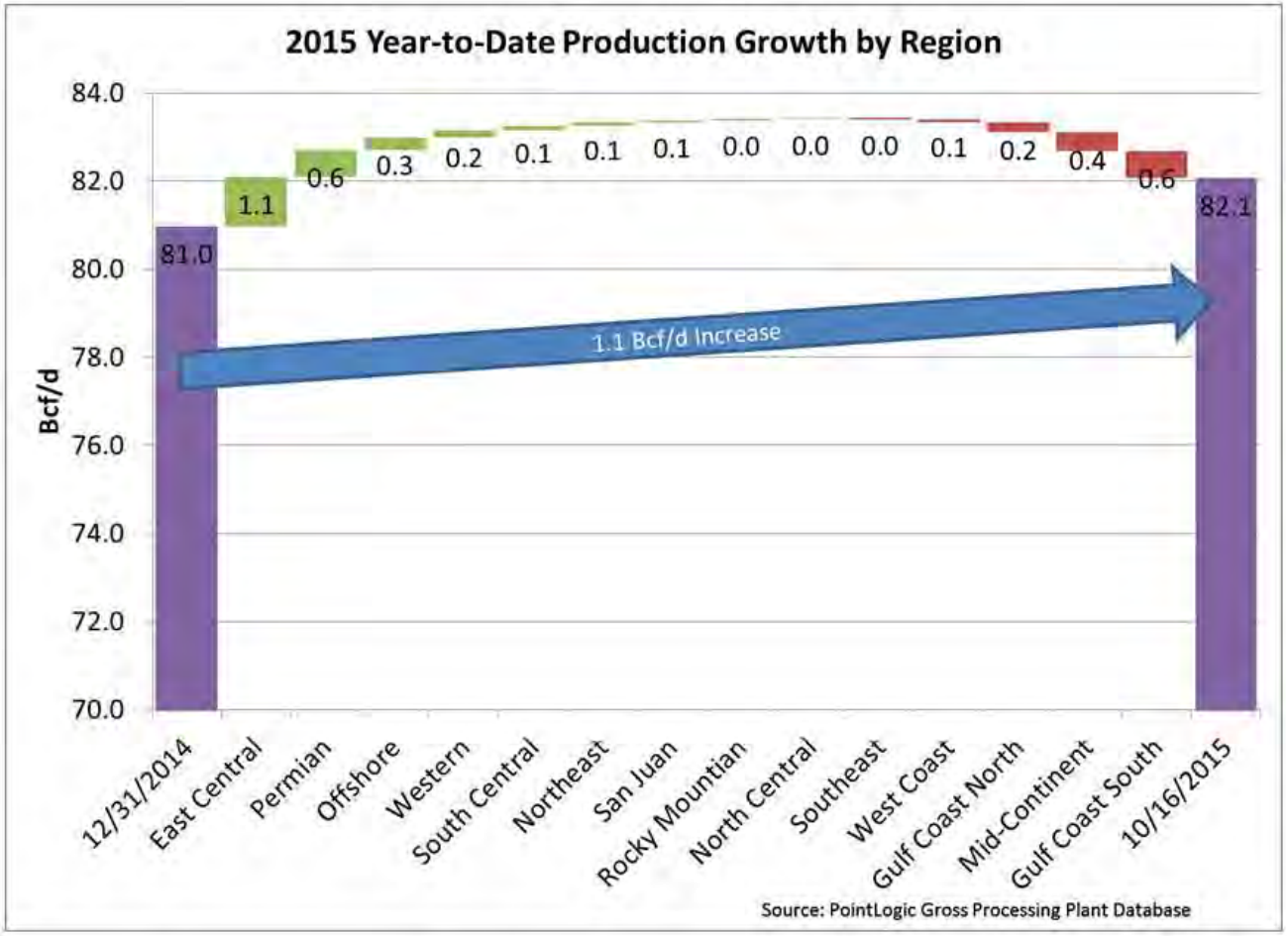
Will Declines Overtake Growth in 2016?



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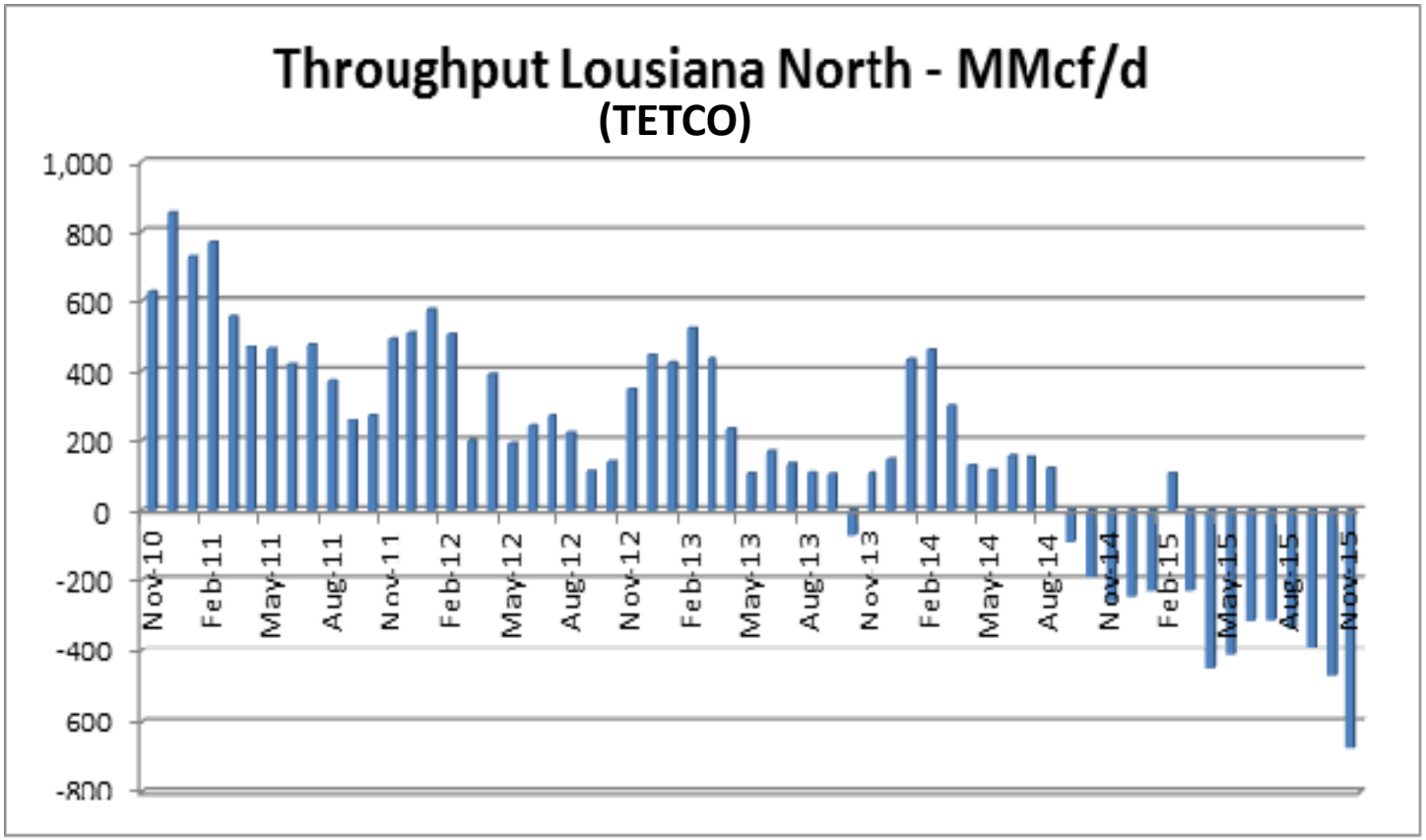
Pipeline Logistics Forever Altered?



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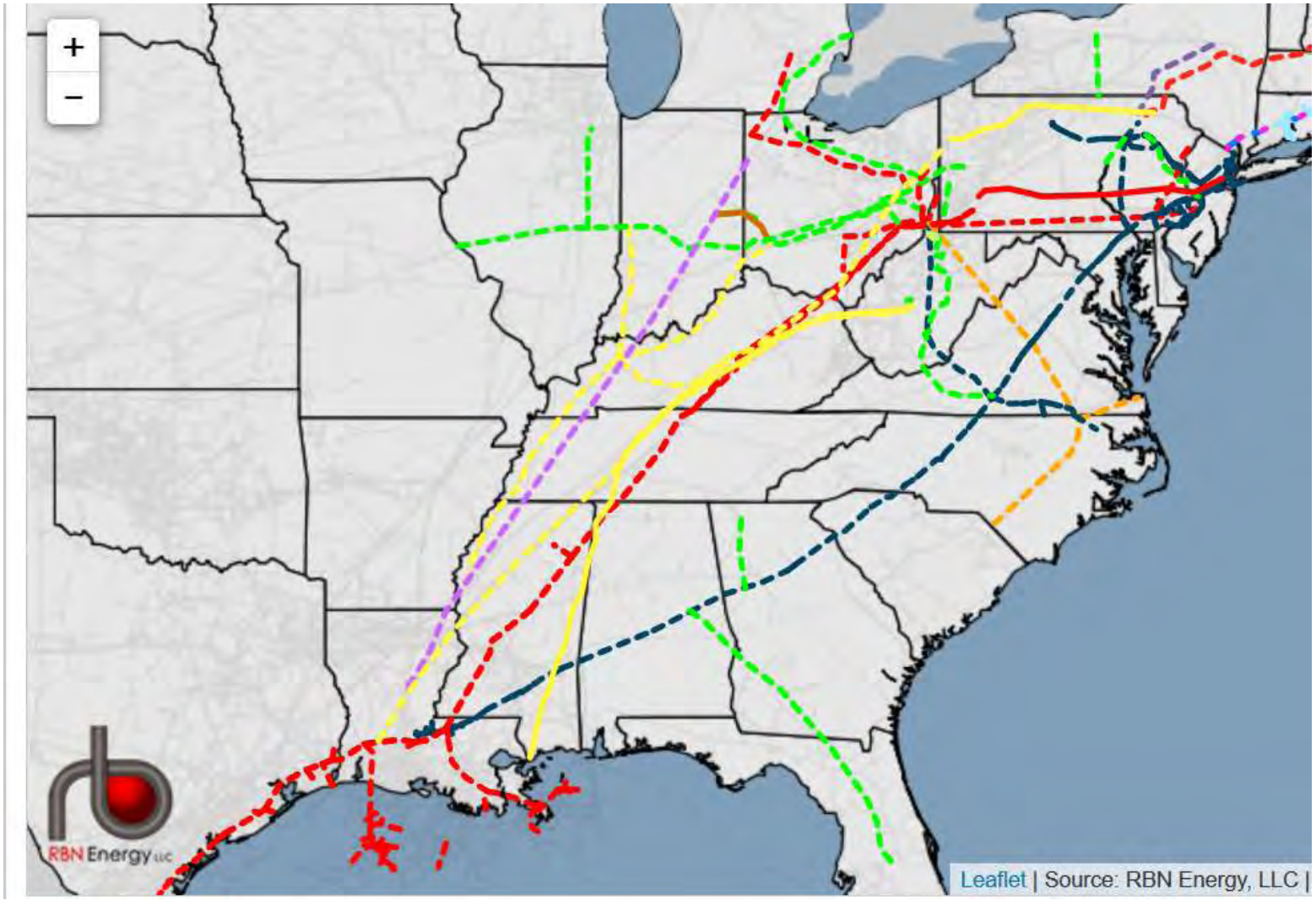
Natural Gas Projects



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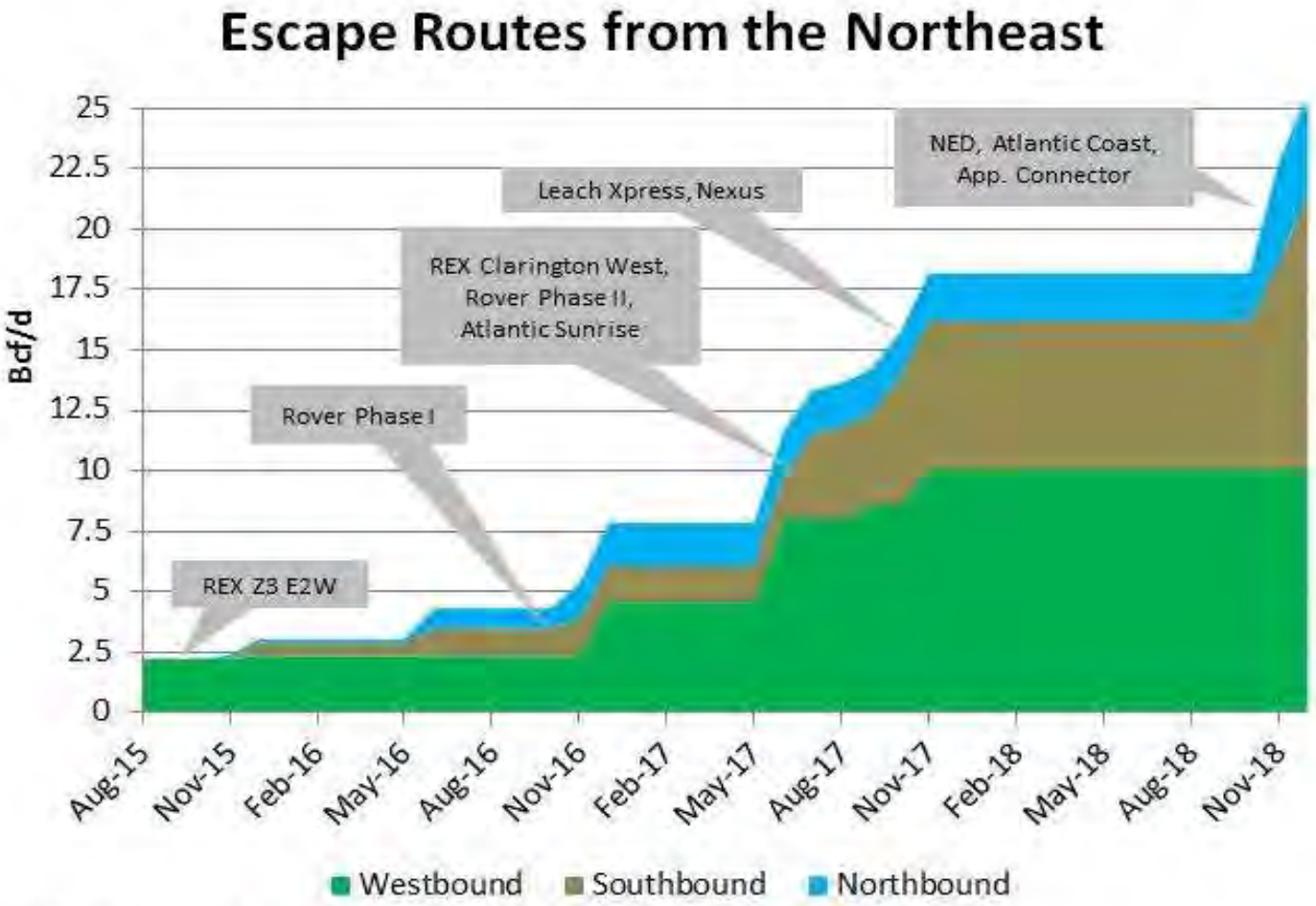
Capital's Been Focused on the Northeast



Source: PointLogic Energy

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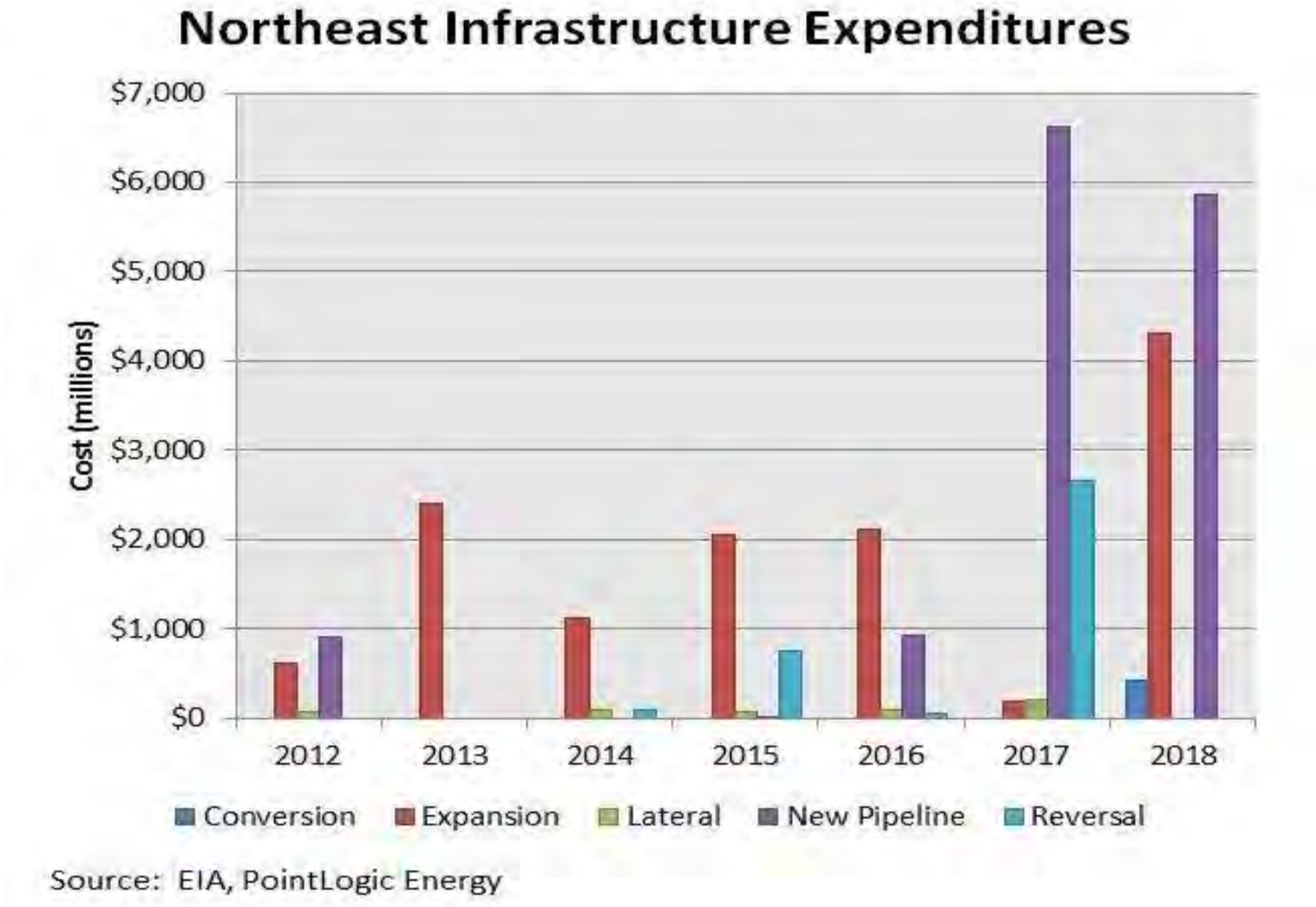
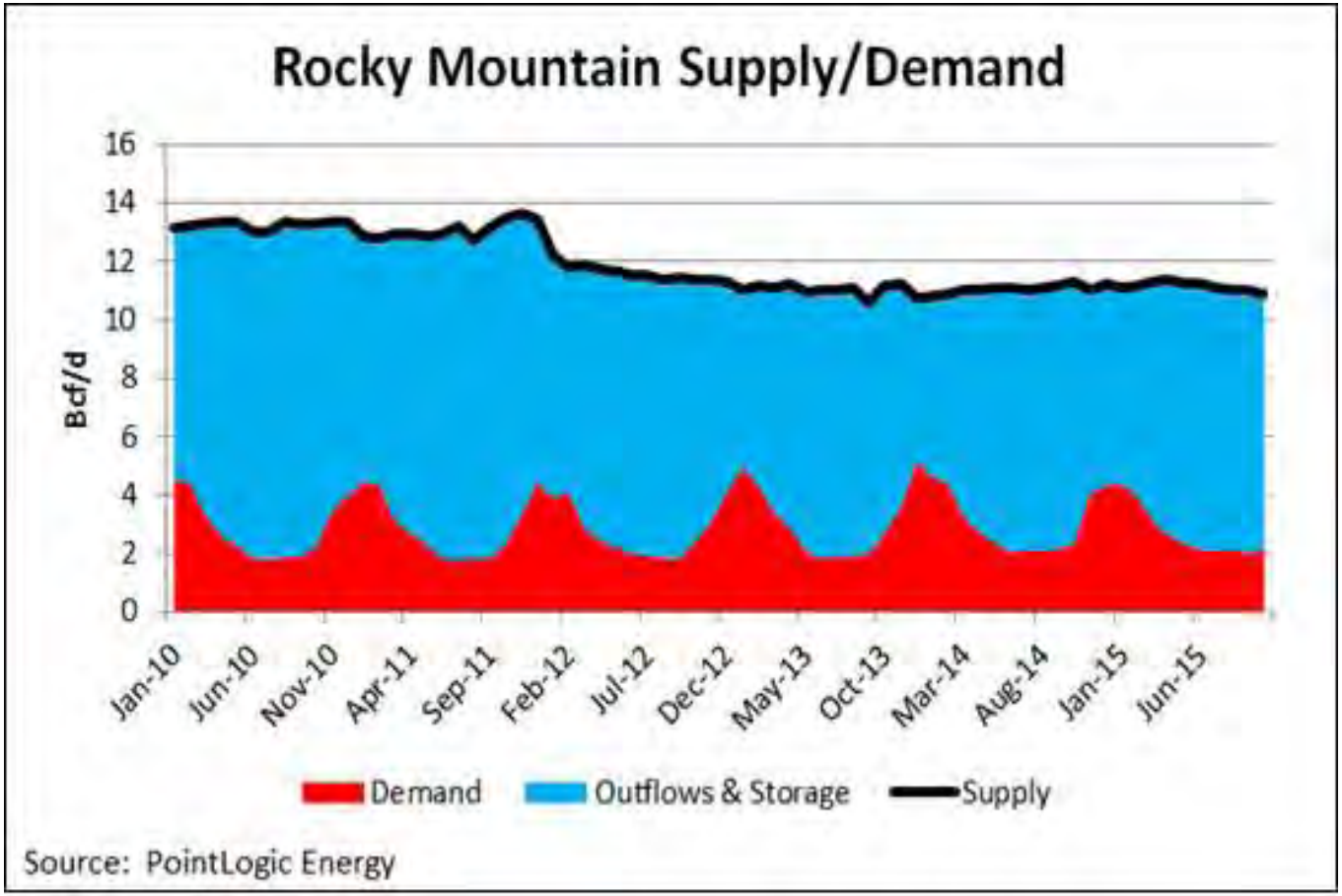
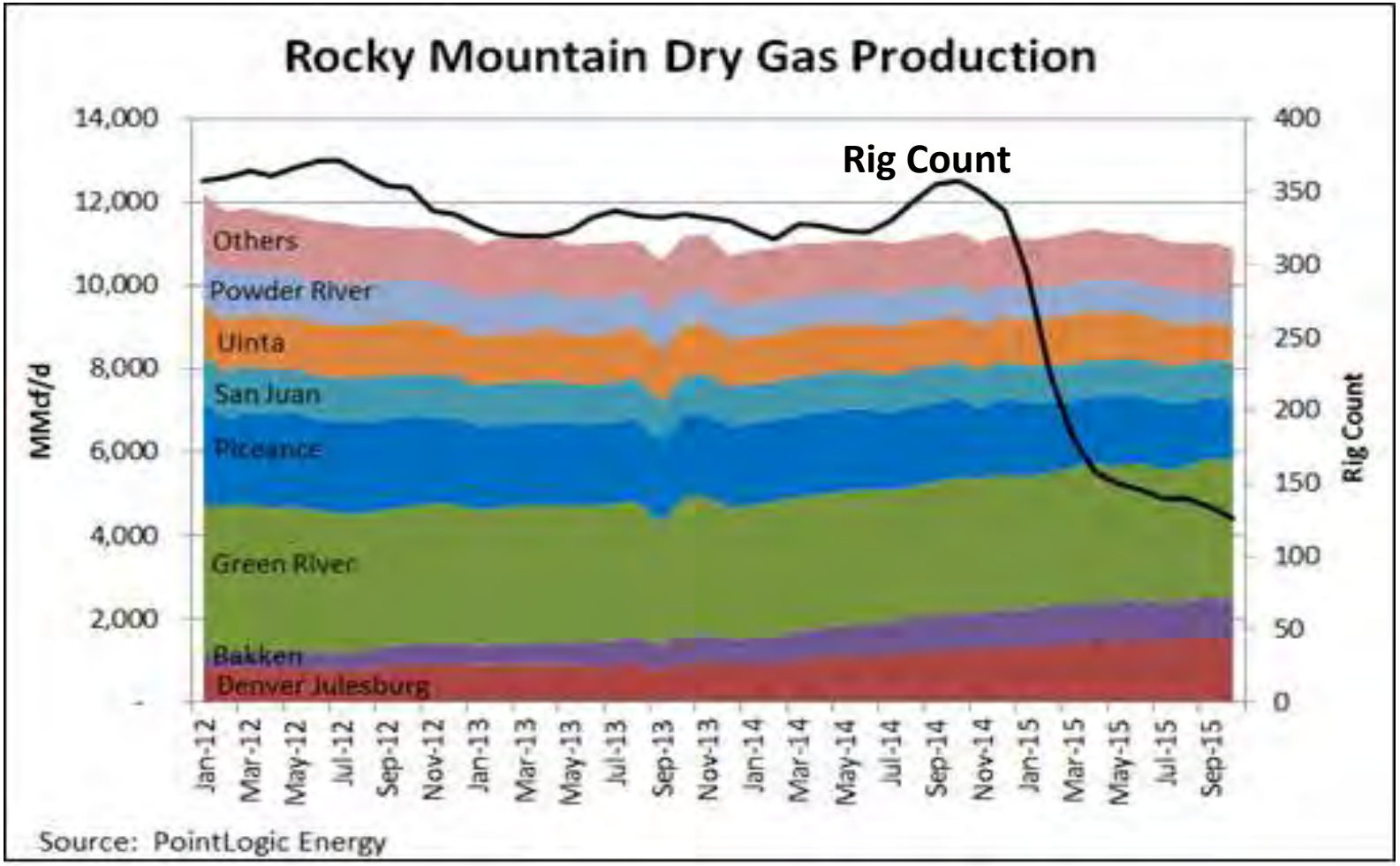
Are 2017-18 Projects in Jeopardy?



Any Issues to be Addressed in the Rockies?



Some RM Basins Still Show Growth



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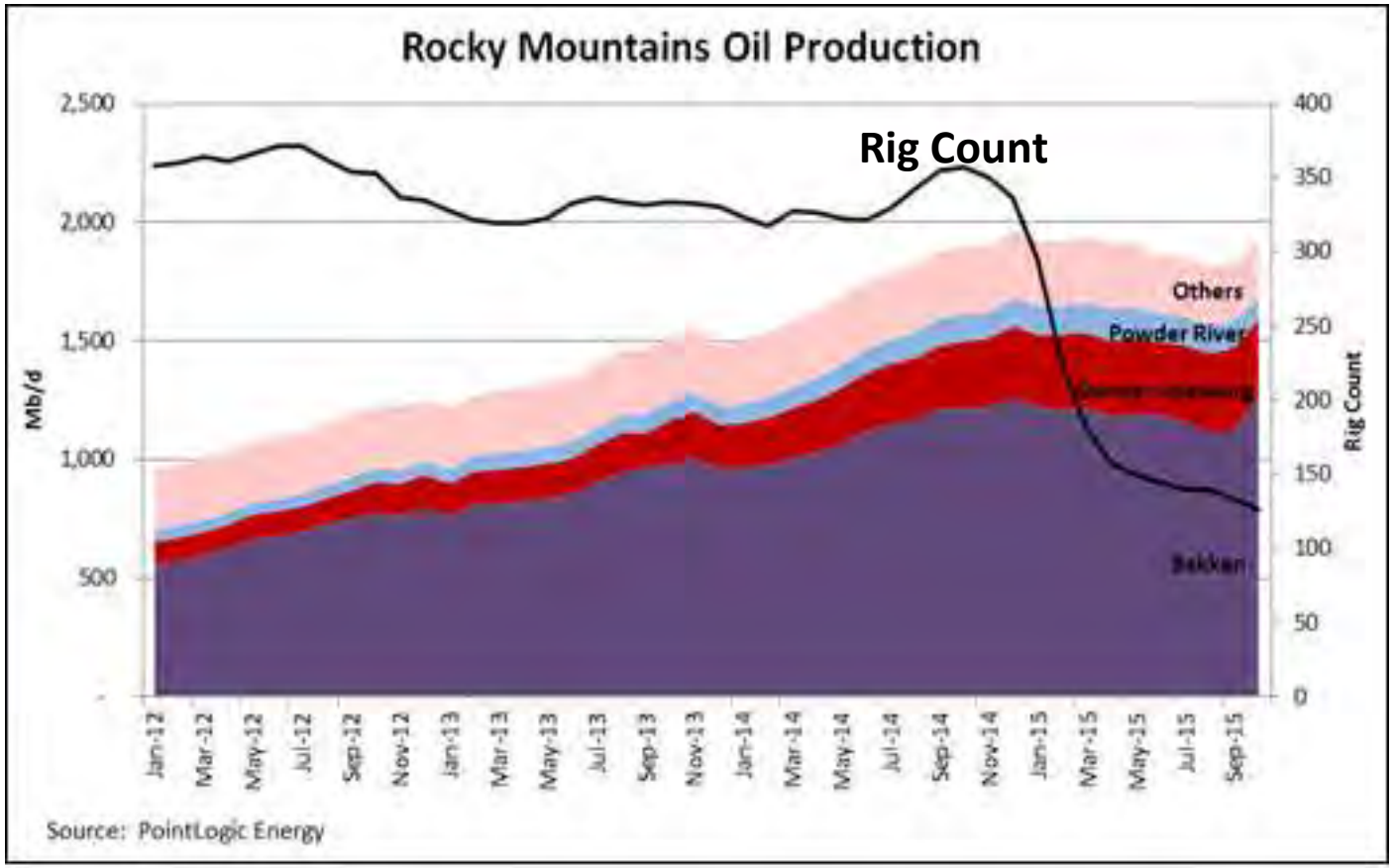
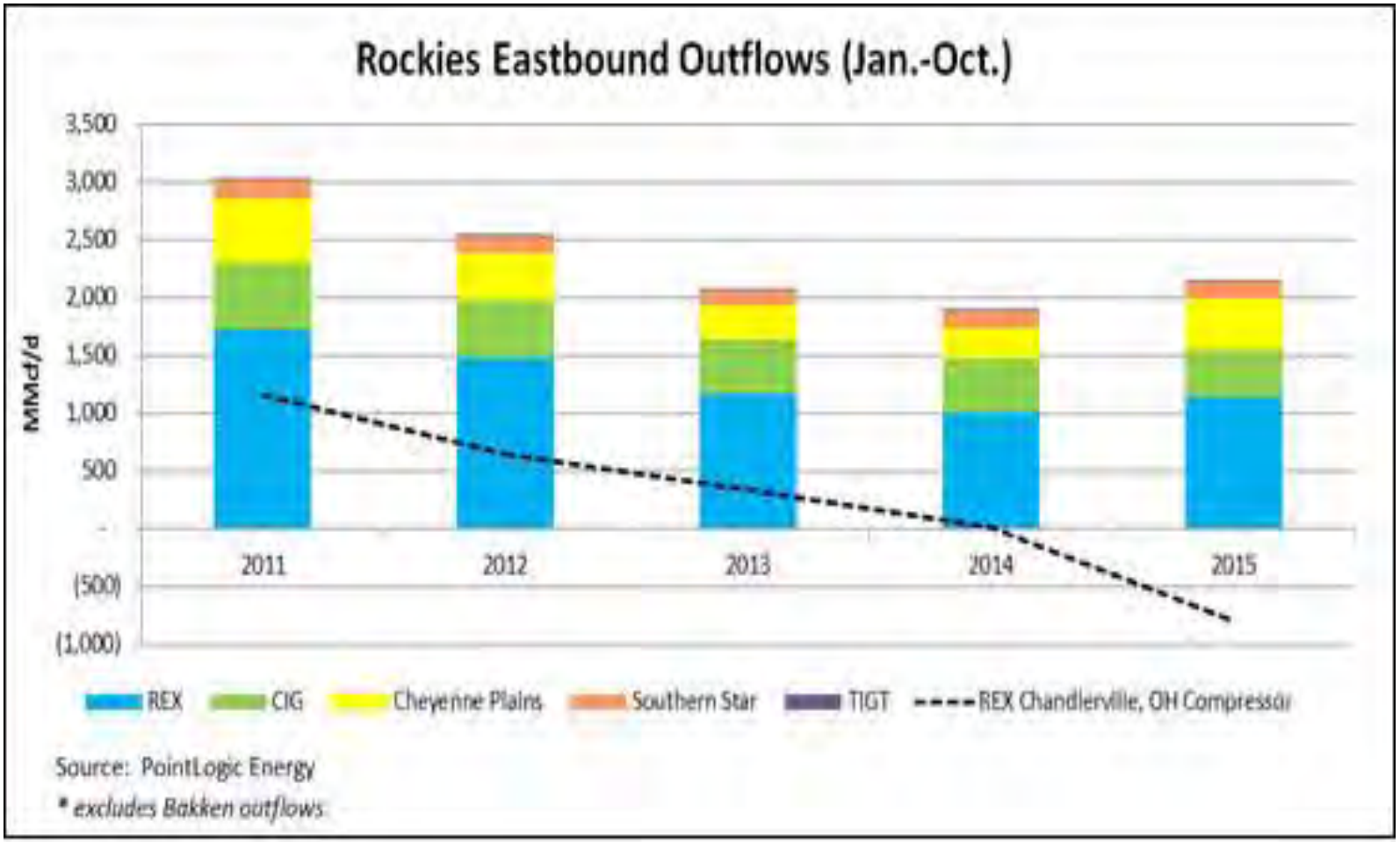
Is the Rockies Over/Underbuilt?



Most of the Rockies Gas Gets Dumped Early



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Big Ticket Projects

SPECIAL ECONOMICS, SPECIAL REGIONS AND VERY SPECIAL FRAMEWORKS

Some Ideas/Concerns From 2014 Workshops

- What is the global market for US LNG?
- Could China's natural gas demand decline? Could LNG be replaced by piped gas or nukes?
- Is competition from coal and renewables still an issue for natural gas?
- Are natural gas prices delinked from oil prices?
- Are big potential natural gas importers developing substitutes for natural gas/LNG?
- Status of global natural gas infrastructure development

Insights from China and India Natural Gas Demand Research

- 43% of gas consumption in China is from industrials-fertilizer, glass, paper, steel and petrochemicals-experiencing overcapacity and weak profitability. Transitioning economy away from these industries.
- Power accounts for 18% of China's gas consumption primarily for peaking in coastal areas. Power consumption growth rates are declining. Base load power generation expected to come from coal (9 new clean coal power bases in West) and nuclear (25 units under construction). Gas relegated to peaking?
- Residential gas consumption in China (20% of gas consumption) is growing-only 16% of population has access to piped gas. Growth potential in North. Big enough to offset potential declines in industrial gas consumption?
- Industrial and power gas prices linked to fuel oil and LPG prices. Historically substantial price subsidies. Coal generation about 25% cheaper than gas generation.

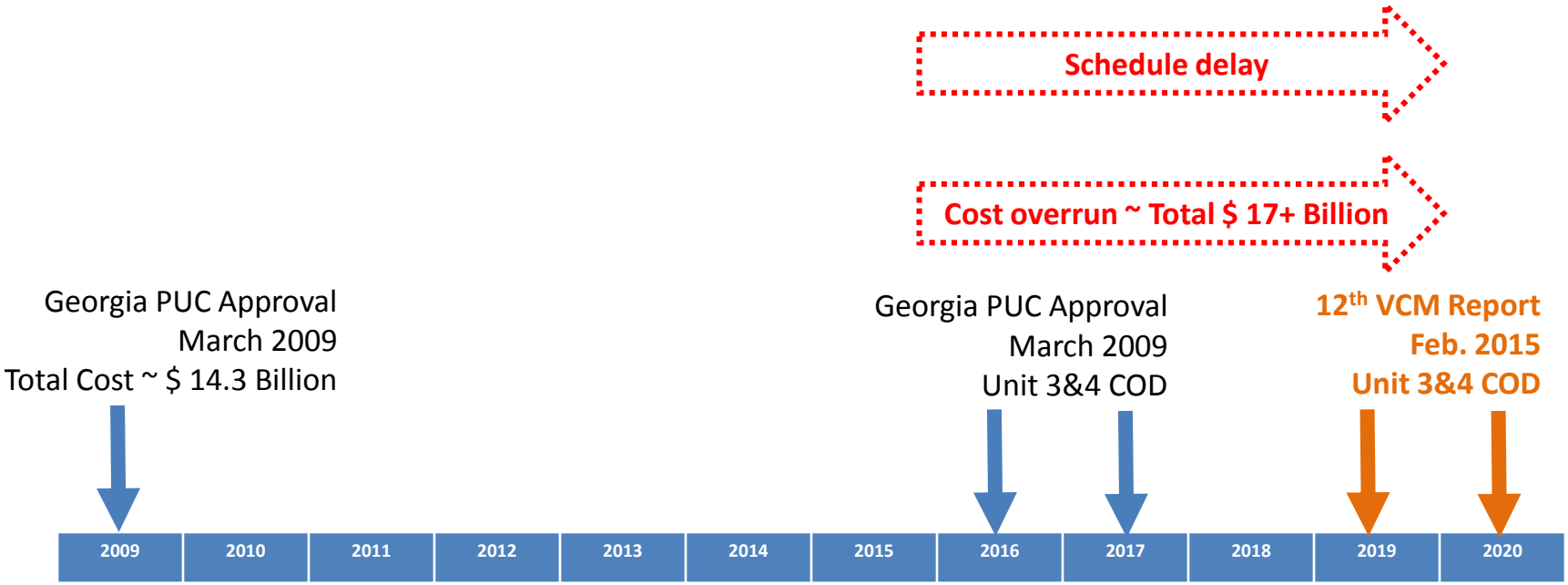
Insights from China and India Natural Gas Demand Research

- 82% of India's gas consumption is from power and industries
- Power sector gas consumption has been declining since 2010 constrained by lack of supply and inadequate infrastructure. In early 2015 53% of gas generation capacity had zero supply and 36% operated at 30-40% load factors.
- Power sector renewables consumption about equal to gas consumption in 2013. India recently announced aggressive solar development program targeting mainly rural areas where about 300 million are without electricity.
- Gas-fired generation (7% of total) is expensive relative to coal-fired generation (71% of total) at domestic prices of about $5.00/MMBtu. 84% of supply is from less expensive domestic sources. Power sector is financially weak and heavily subsidized.
- Industrial gas demand has been flat since 2010. About 50% of non-fertilizer industrial gas consumption comes from LNG.
- Indian gas midstream infrastructure is inadequate to move supply to demand centers. Infrastructure expansion impeded by land acquisition policies.

Some Ideas/Concerns From 2014 Workshops

- What is the global market for US LNG? WEAK AT PRESENT
- Could China's natural gas demand decline? YES Could LNG be replaced by piped gas or nukes? NUCLEAR AND CLEAN COAL FOR BASELOAD
- Is competition from coal and renewables still an issue for natural gas? YES
- Are natural gas prices delinked from oil prices? STILL LINKAGES WITH OIL BASED SUBSTITUTES
- Are big potential natural gas importers developing substitutes for natural gas/LNG? YES ESPECIALLY FOR POWER
- Status of natural gas infrastructure development MORE DEVELOPED IN COASTAL CHINA. INDIA HAS MAJOR DEFICIT.

Vogtle Unit 3&4
- Southern Company (Georgia Power)
- 2 * Westinghouse 1,250MW AP1000 Reactor



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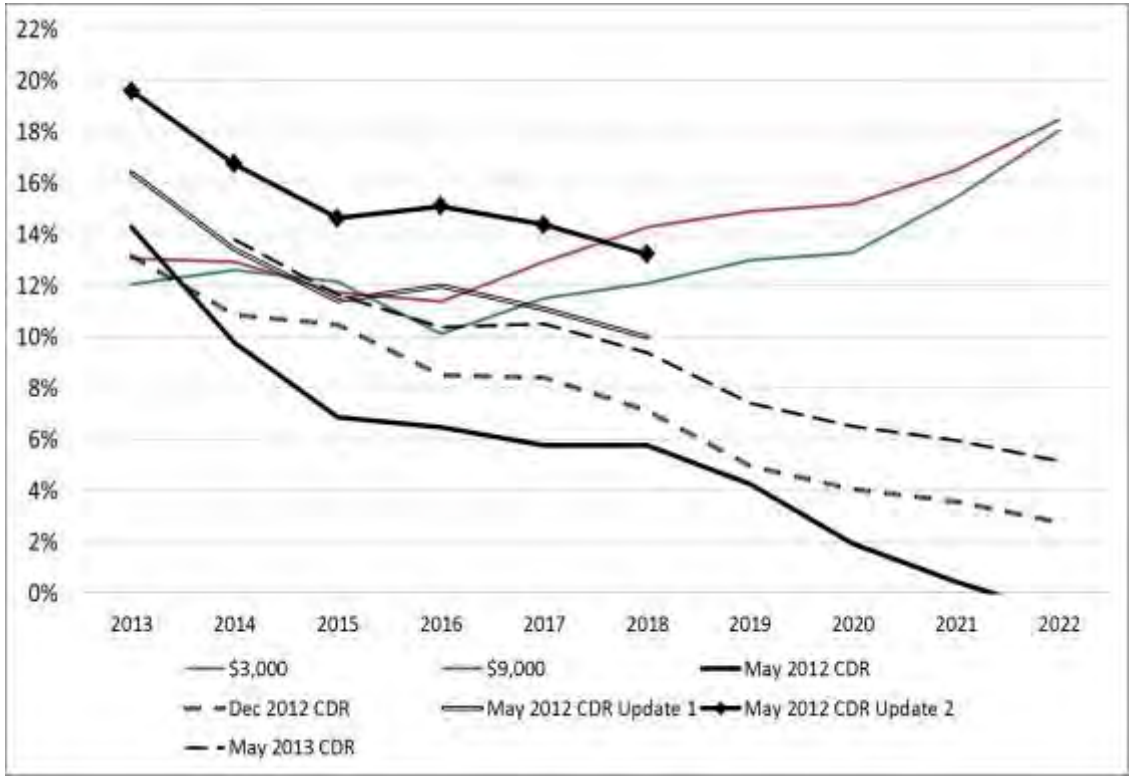
CLOSING THOUGHTS FOR DAY 1, LOOK AHEAD TO DAY 2

Invited Dinner Keynote – Sheila Hollis

WHEELING AND DEALING IN WASHINGTON IN 2016

FUZZY LOGIC?

ERCOT Resource Adequacy: Higher Price Cap Should Increase Reserve Margin



- ERCOT is an energy-only market (i.e., no capacity markets)
- Marginal fuel is natural gas + >10 GW of wind ➔ low electricity prices since 2010 (except for August 2011)
- Price cap increase should help but
- Reserve margins also depend on environmental regulations, share of renewables, price of natural gas

Gülen & Soni, The Impacts of Raising the Energy Price Cap in ERCOT, The Electricity Journal, 26(7), 43-54.

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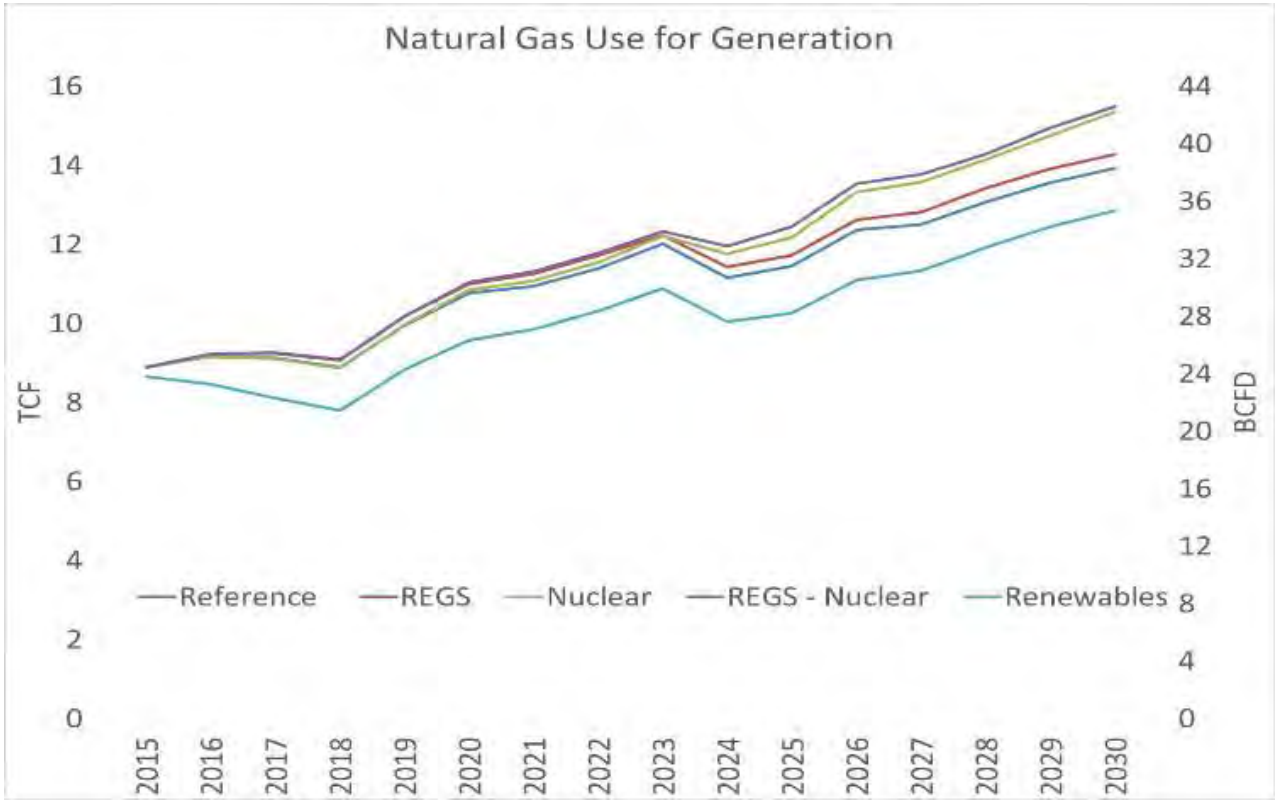
Natural Gas Consumption Increases Significantly Even With More Renewables

Work in Progress – Do Not Cite



- The model builds CT primarily, partially because natural gas price remains low
- ~12 GW of CC under construction or in advanced development were added for all scenarios as well as 5.5 GW of nuclear
- The renewables case is aggressive, including ~58 GW of wind and ~27 GW of solar, including "announced" projects

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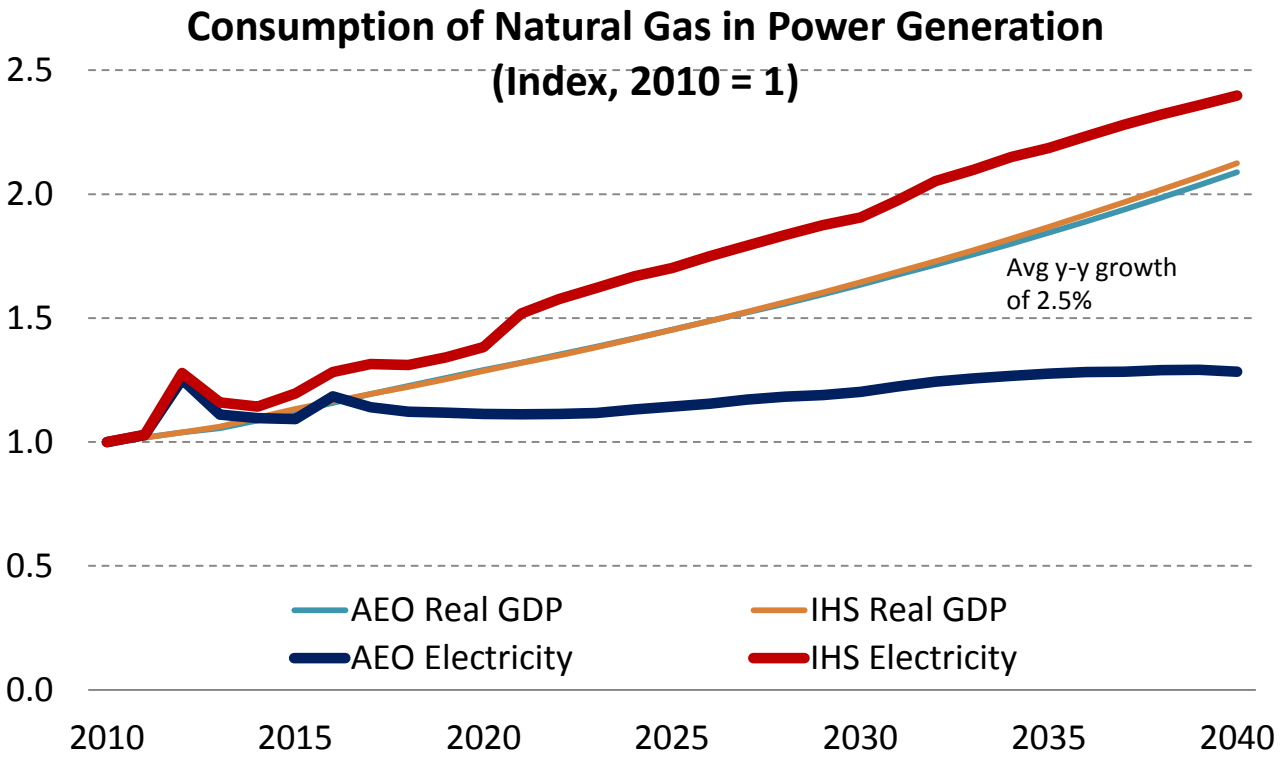
But, What Future do you Expect?



- More energy efficiency and conservation (AEO reference scenario 0.8% annual growth in electricity use)
- More renewables
- More generation from nuclear

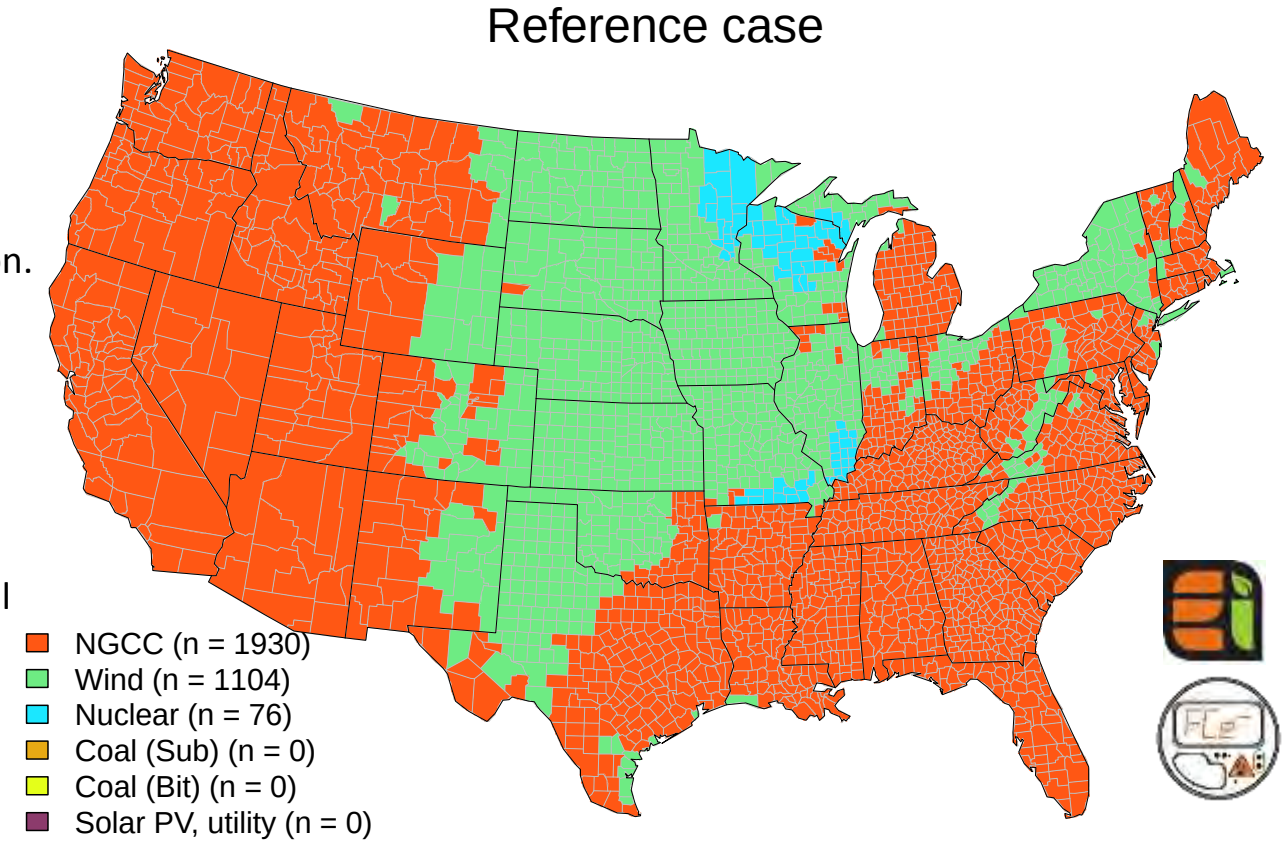
Based on data from EIA AEO 2013* & IHS Global Insight
* AEO 2014 and AEO 2015 are similar.

Also, What Cost of Generation?

Work in Progress – Do Not Cite

LCOE is imperfect but used a lot!
LCOEs on this map

- Cover capital, operating, fuel and emissions costs, including social cost of carbon of $63/ton.
- Do not cover T&D costs.
- Do not consider access to cooling water.
- Do not consider local constraints.
- Regional variation due to differences in overnight capital and fuel costs, and capacity factors.



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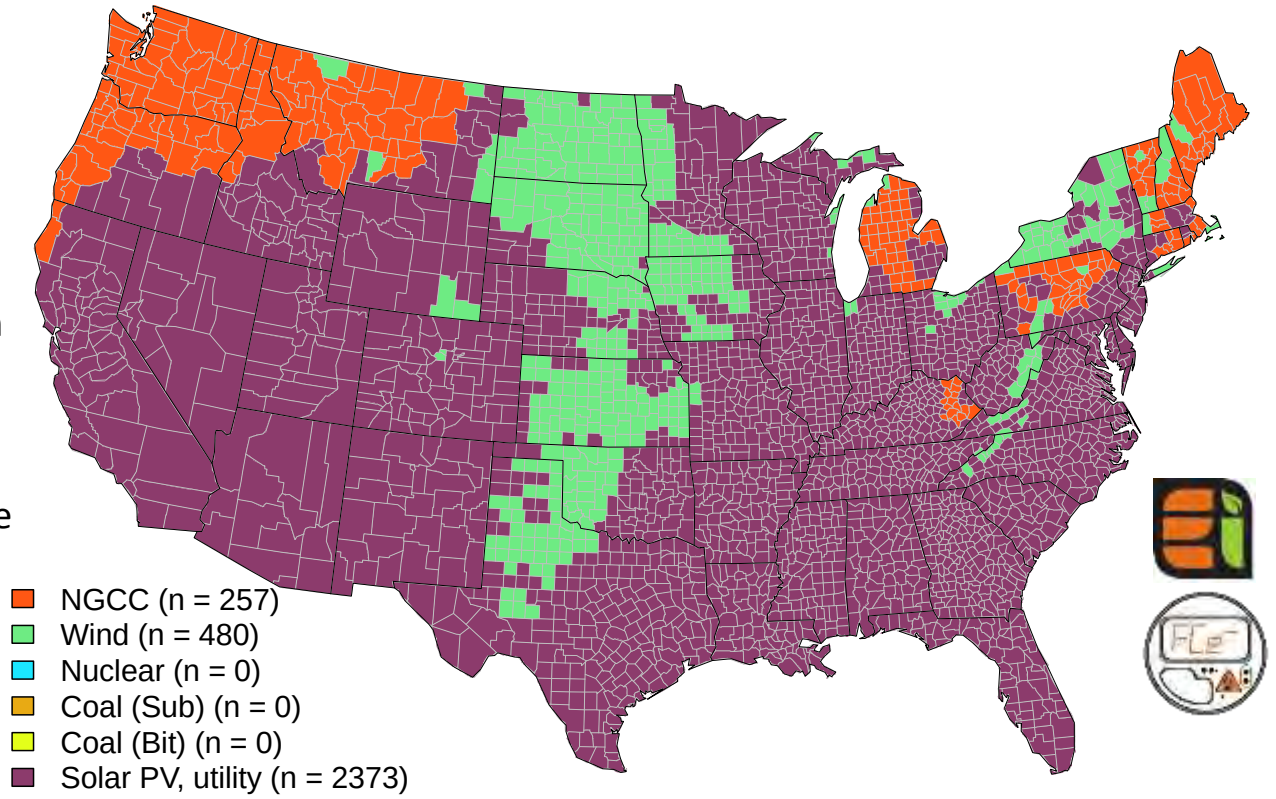
Potentially Major Game Changer: Utility-Scale Solar PV Cost Declines to $/1 W Installed

Work in Progress – Do Not Cite

- Used $2.7/W in the Reference Case, which is based on 2013-14 engineering design studies
- Solar industry already claims <$2/W but reported installed costs have been higher
- Without storage, solar expansion will be curtailed
- Power purchase agreements signed by utilities offer prices as low as $40-50/MWh, competitive with cheap gas-fired power (e.g., Austin Energy and CPS in Texas)

Reference case with low solar CAPEX ($1/W)



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LACE Incorporates Portfolio Mix (If LACE>LCOE, "economic") – ERCOT Scenarios (2014-2030)

Work in Progress – Do Not Cite

$2014/MWh	Current Trends	CT with High NG Price	Aggressive Renewables	AR with High NG Price
Wind	31.8	**61.7**	30.4	**54.8**
Solar	36.8	**70.5**	36.1	**67.5**
Gas – Non-Cycling	39.9	**85.8**	40.6	**86.1**
Gas – Peaking	80.9	**162.1**	88.6	**168.7**
Coal	45.5	**65.4**	46.3	**63.1**

- Low NG prices ($3-4 through 2030): LACE < LCOE with the possible exception of gas units.
- High NG prices ($8 by 2027): LACE > LCOE with the possible exception of solar under most assumptions.

Sponsored by UT Energy Institute as part of the Full Cost of Electricity (FCe) research program.

Even LACE Does Not Tell the Whole Story – How About Total System Costs

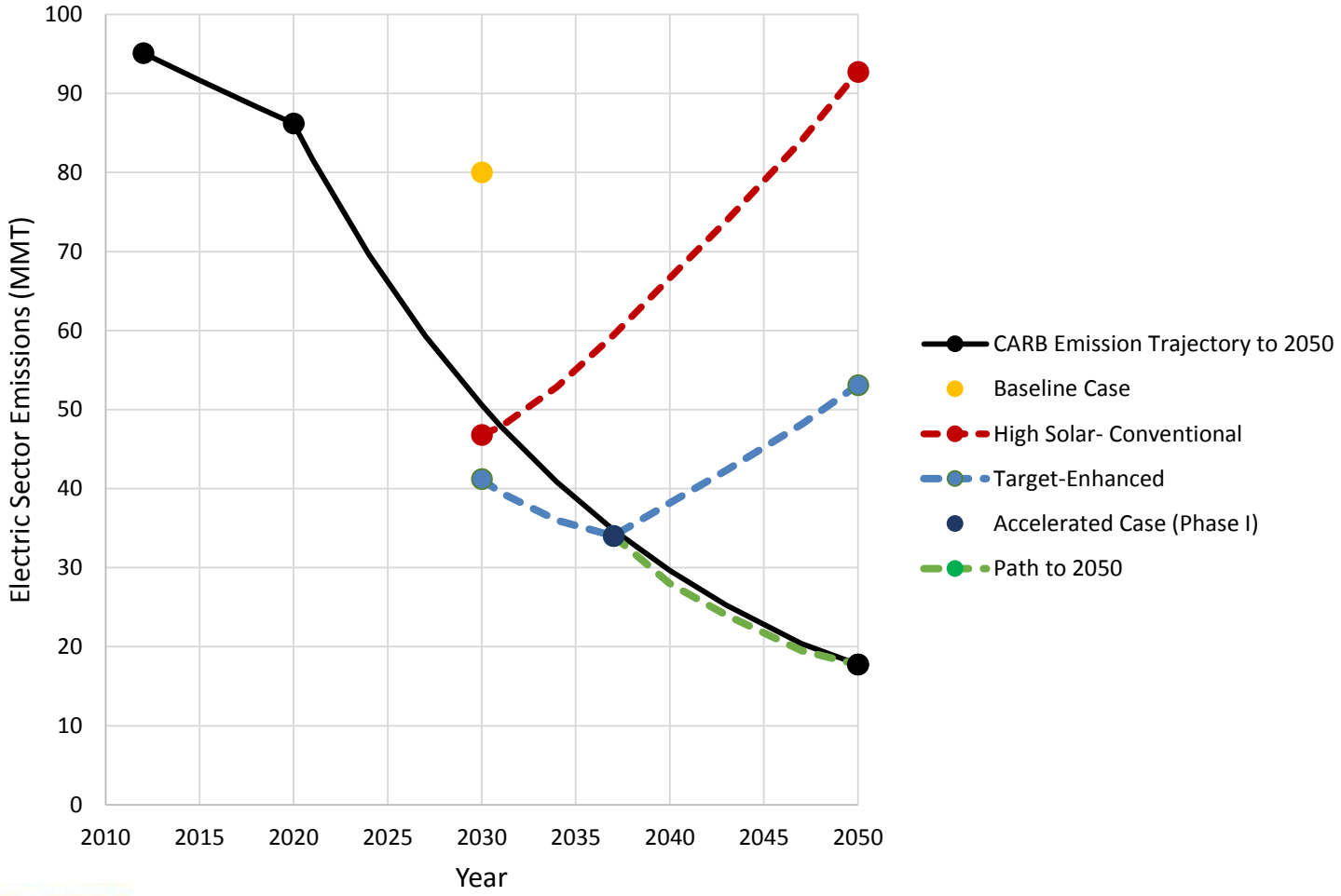
Work in Progress – Do Not Cite

- Aggressive Renewables (AR) scenario costs ~$20 billion more in overnight capital costs than the Current Trends scenario
- AR saves ~$630 million in fuel and operating costs in 2030
- Assuming the same savings every year (2014-2030), AR can save ~$10 billion, half of the capital investment
- Assuming emissions savings are as high every year as 2030 and $100/tCO2, savings from emission costs can be ~$36 million, minimal as compared to other costs

Sponsored by UT Energy Institute as part of the Full Cost of Electricity (FCe) research program.

CEERT Low Carbon Grid Study

Towards 2050:
CA Carbon Emission Trajectories



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Electric Utilities – Evolving not Dissolving

- Gradual interest rate increases unlikely to cause a financing crisis
- Existing central station power is subject to tightening pollution rules
- Oversupply in power portfolio hasn't been rationalized
- "Big" transmission is not actually happening
- Energy efficiency a legacy of California Energy Crisis prices
- Economies of scale hard to sell in an smart phone world?
- Average retail net metering divides customers
- Push to empower consumers' ability to manage energy consumption
- Resiliency starts at home?
- The morality of buying groceries locally…

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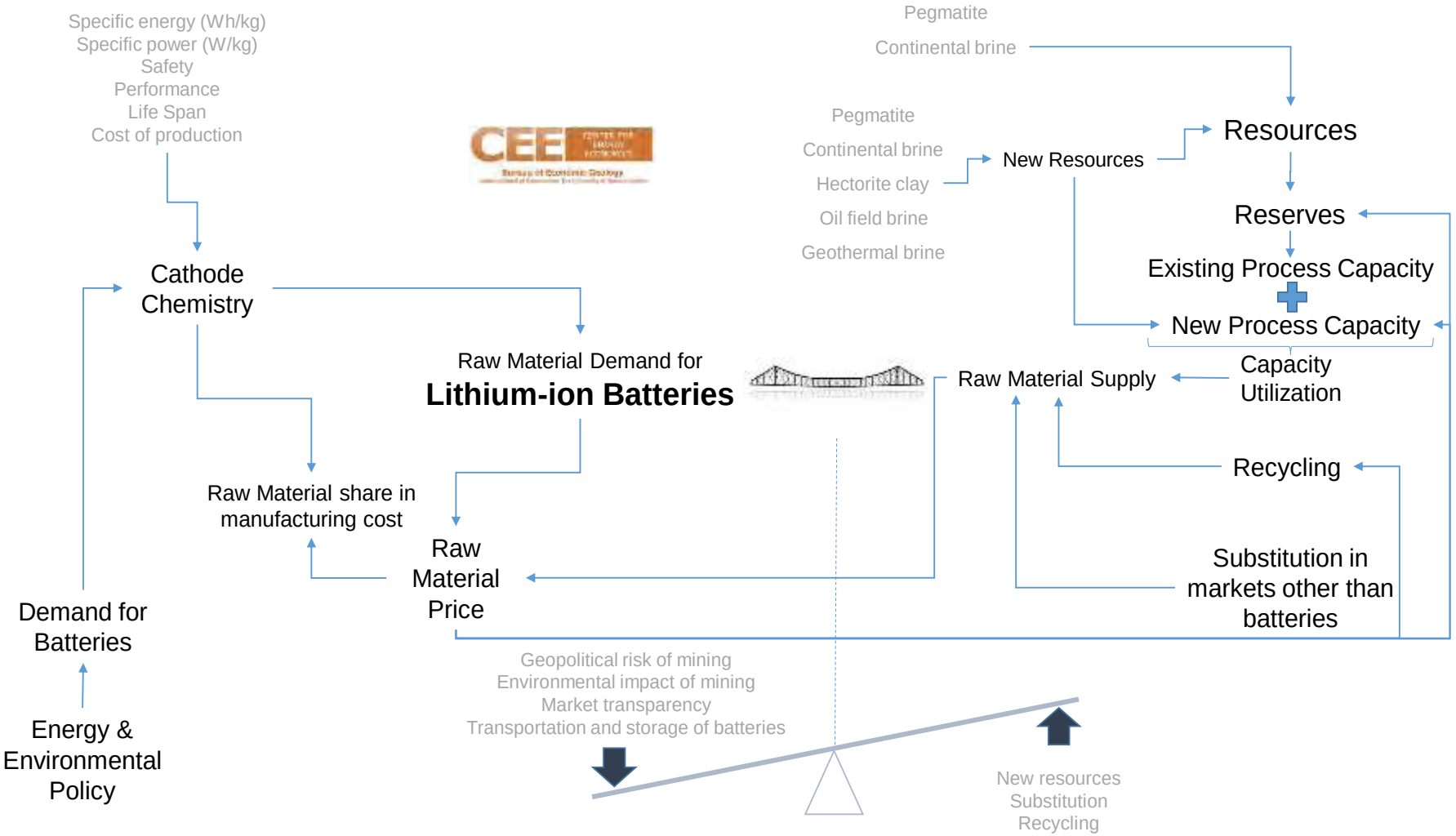
Electric Utilities – Evolving not Dissolving

- ***Clean Power Plan* structure creates opportunity to use options beyond utility scale renewables and natural gas for compliance**
- **Distribution level investment empowers state regulators**
  - Energy efficiency reduces demand
  - Demand response and storage flatten the load curve
  - Retail self-supply pushes back on distrusted centralized wholesale markets
  - Distribution level investment implies improved reliability/resiliency
  - Cost of capital advantage via utility balance sheet finances
- **Public utilities have called the bluff on average retail rate net metering**
  - Little wisdom in abandoning the existing system before it is paid for
  - Have no profits to use to fund overpayment of solar DG
  - Could help drive constructive changes in rate design (moving to fixed charges and time of use, fees for services)

Power and Utilities Part II

TRANSMISSION AND STORAGE

Roadmap



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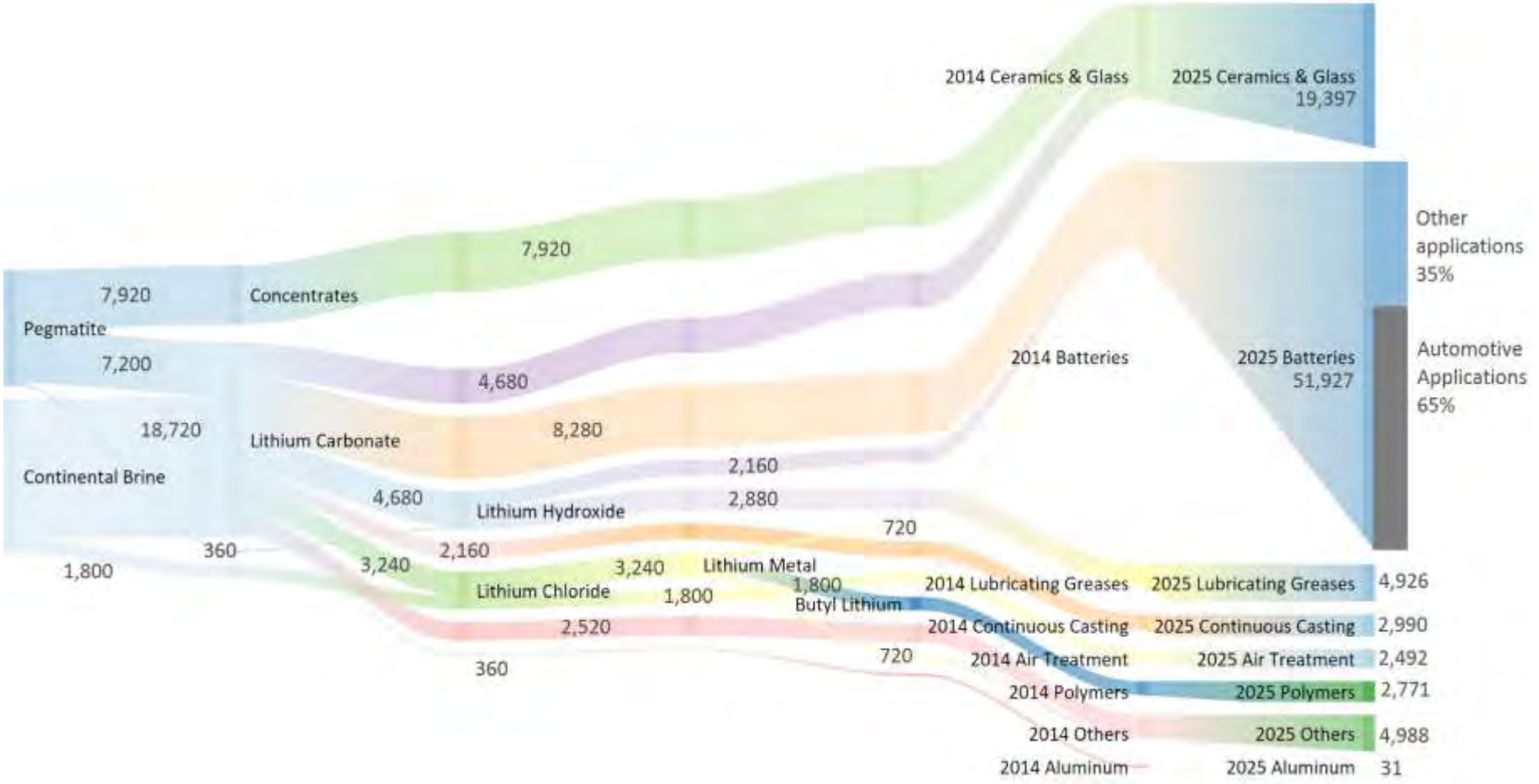
Li Value Chain/Flow Diagram



The data and end use information for calculation of this lithium flow diagram is derived primarily from USGS (2013), Yaksic (2009), Gruber (2012), Peiro (2013), Evans (2014) and Deutsche Bank (2011) and from information published by major manufacturers like Albermarle Corporation and FMC.

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CLOSING THOUGHTS DAY 2, COMMENTS ON/RECOMMENDATIONS FOR CEE RESEARCH

Day 2 Luncheon Keynote – Ed Kelly

TECHNOLOGY DISRUPTIONS – GAS AND POWER "DEEP DIVE"