July 6, 2016

MEMORANDUM

TO: **Power Committee Members**

FROM: **Steven Simmons**

SUBJECT: **Eight Years into the "Shale Gale" – Natural Gas Supply, Demand and Prices**

BACKGROUND:

Presenter: Steven Simmons

Summary: North America is now into the eighth year of the "shale gale". Technological advances in horizontal drilling, hydraulic fracturing, and seismic imaging has opened up vast new natural gas supplies in the United States and Canada. As a result, drilling efficiencies have greatly improved, production is at historic highs, and prices have remained relatively low and stable. With the recent supply surplus, natural gas flow dynamics have been altered, and the United States is on the verge of becoming a net exporter of natural gas for the first time since the 1950s.

Staff will review recent trends in natural gas supply, demand, and prices with a particular focus on the Northwest.

Relevance: Natural gas supply, demand and price play an important role for regional consumers of both natural gas and power. With looming coal power plant retirements, the region may see an increased reliance on natural gas fuel for power generation. Assumptions around gas supply and prices also factor into many of the Council's planning models and tools.

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Workplan: A.3 Forecasting and Economic Analysis

Background: Staff is expected to reconvene the Natural Gas Advisory Committee later in 2016 to review the status of gas in the region. Staff will also be updating the natural gas price forecast by the end of 2016, roughly one year following the final forecast from the Seventh Plan.

More Info: NA

Eight Years into the "Shale Gale" - Natural Gas Supply, Demand & Prices

Steven Simmons
Olympia, Washington
July 12, 2016

Northwest Power and Conservation Council

Today's Theme

Advances in technology - "smart drilling" has opened up vast natural gas resources across North America

1. Hydraulic Fracturing
2. Horizontal Drilling
3. Advanced 3D Imaging

Eight years in shale, what does the natural gas picture look like for the US and our region?

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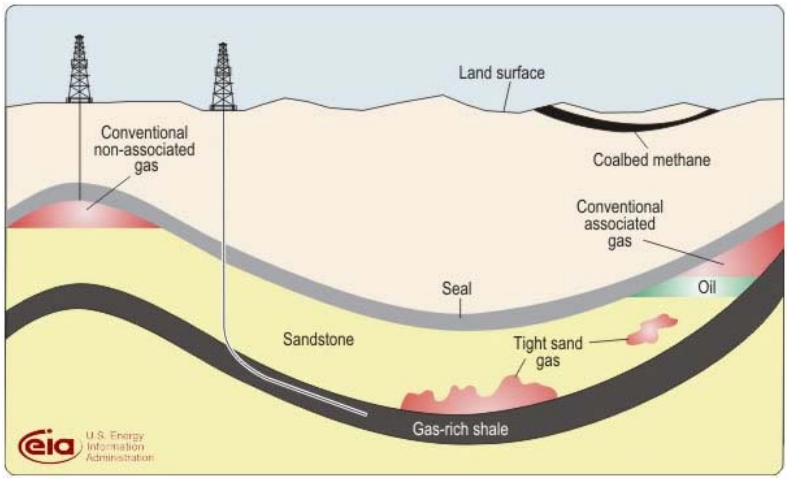
Today's Discussion

1. Supply
2. Demand
3. Prices
4. Storage and Environmental Issues



1) SUPPLY

Shale Boom

- Gas production from shale has surpassed that of conventional and tight gas
- "Smart Drilling" technology continues to improve – boosting efficiencies
- Natural gas supply base is large – estimate for the US alone is 2,500 Tcf – nearly 100 years worth of demand
- Gas flow dynamics have been altered and the US is set to become a net exporter of gas

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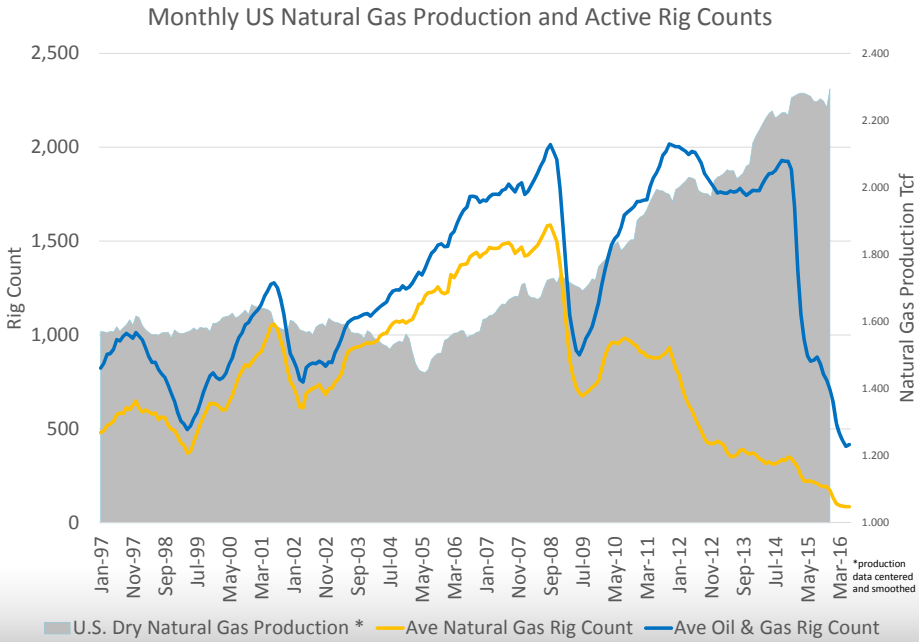

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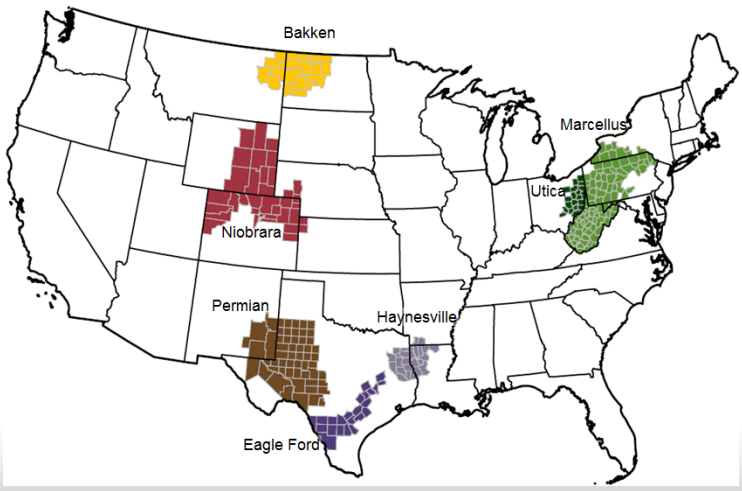
Natural Gas Production

Active rig count as a leading indicator for production is not as reliable as it used to be

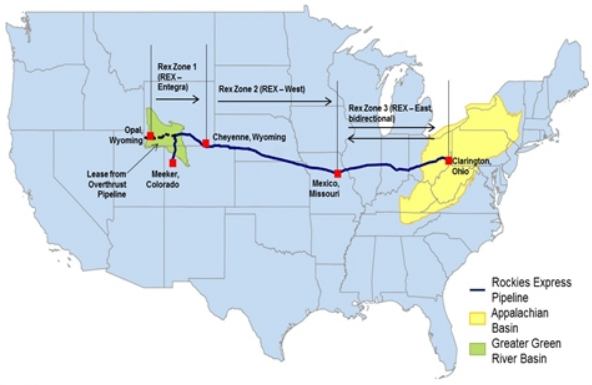
1. Greatly improved drilling efficiencies in shale
2. Current backlog of DUCs (drilled but uncompleted wells)
3. Associated gas from oil drilling
4. However – current rig counts are really low from a historic perspective

Major US Shale Basins



Changing Natural Gas Flow Dynamics

Rockies Express Pipeline (REX) with associated natural gas basins



eia Source: U.S. Energy Information Administration

- REX – Completed in 2009, 1,700 mile pipeline to bring US Rockies gas to Midwest and Northeast
- REX Zone 3 is now bi-directional – meaning US Rockies and Alberta gas to compete with Marcellus, Utica shale gas in Midwest
- Western Canadian and US Rockies gas look to the West and Northwest for markets

USGS - Mancos Shale
Western Colorado

US Rockies

Mancos Shale – Western Colorado

1. Piceance Basin – source of tight gas before shale boom, shale is source rock
2. USGS resource assessment performed in 2003 estimated 1.6 Tcf of gas
3. USGS resource assessment performed this year estimated – 66 Tcf
4. Colorado wants to find new markets for their gas – much like Western Canada

2) DEMAND

Export LNG – Gulf Coast

- Cheniere Sabine Pass LNG Export Facility
  1. 0.5 Bcfd now, to 4.1 Bcfd by 2018
  2. First shipment in February 2016
  3. Shipments this year to Brazil, Argentina, India and Portugal
- Four more facilities are currently approved by FERC and are under construction – primarily in the Gulf region, and four more approved but not under construction

Export LNG – West Coast

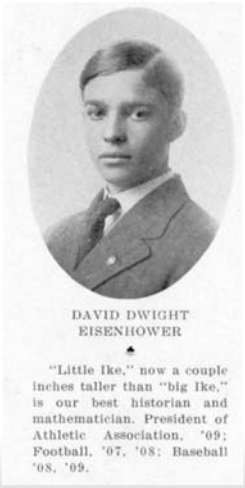
- Two projects approved in Western Canada – including a large facility in Kitimat BC
- FERC denied approval for Jordon Cove LNG in Coos Bay Oregon in March
- US Rockies, British Columbia, and Alberta are looking for markets

Exports via Pipeline

- Pipeline exports to Mexico growing rapidly
  1. NET Mexico Pipeline – new, moves gas from Texas south to Mexico for industrial and commercial, transportation, and power generation
  2. Expansion of pipelines in Arizona down to Mexico boosting exports
- Pipeline imports from Canada are declining
- Add it all up and…..

US to become Net Exporter

In 2016 or 2017 the US is to become a **net exporter** of natural gas – first time since 1957 – see Ike



DAVID DWIGHT EISENHOWER

"Little Ike," now a couple inches taller than "big Ike," is our best historian and mathematician. President of Athletic Association, '09; Football, '07, '08; Baseball '08, '09.

Other Growing Demand

Natural gas consumption for power generation is growing steadily

1. Undercutting coal-fired power, and coal retirements
2. Premature nuclear power plant retirements across the US
3. Not all retirements to be replaced fully by gas – energy efficiency, solar, wind, storage will all factor in
4. Retirements possible because of low priced gas and existing infrastructure

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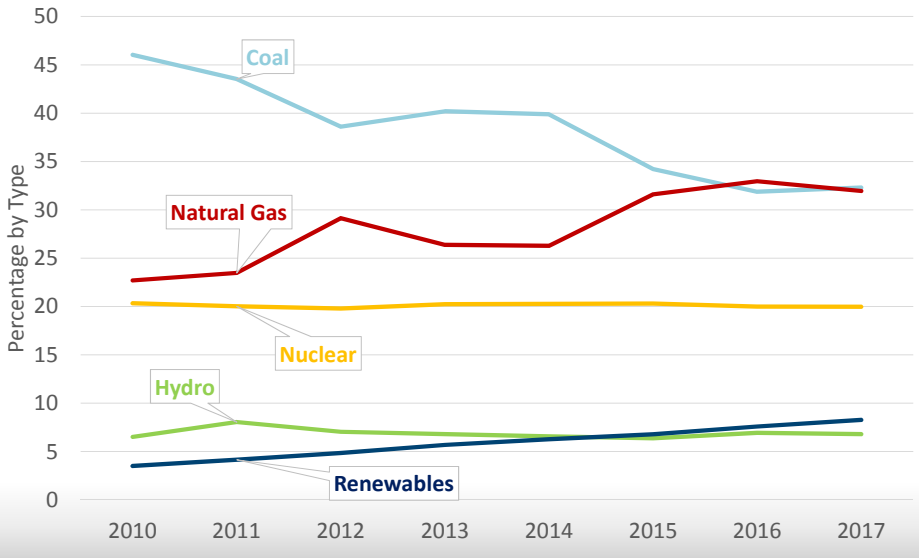
Historic and Near Term Electric Power Generation in the U.S.



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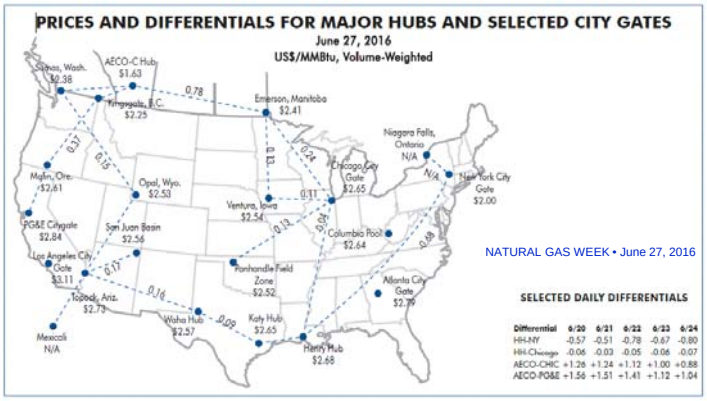
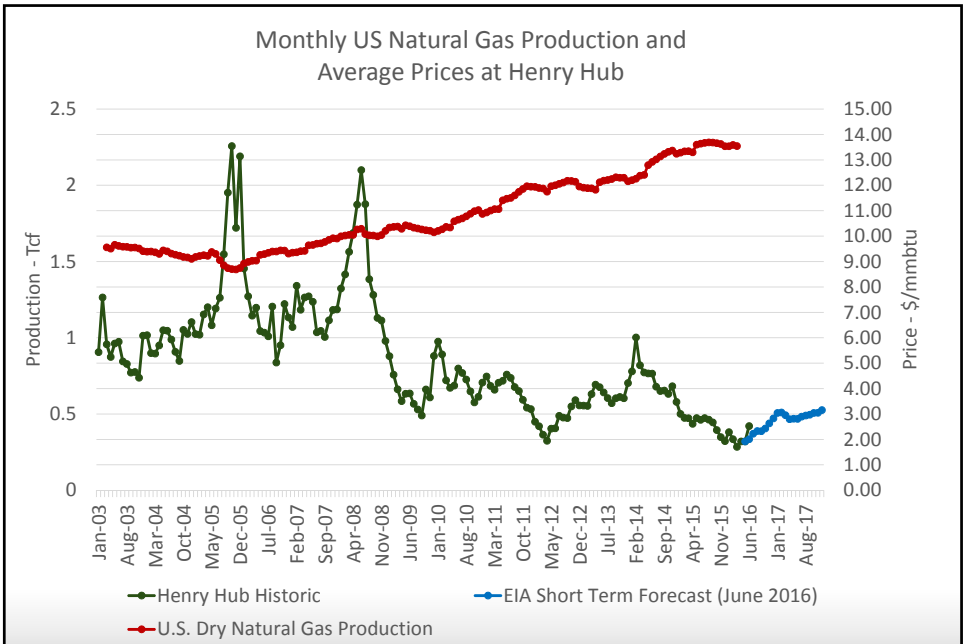
Other Growing Demand

Petro- Chemical Industry

- Methanol plants proposed in Kalama WA and Port Westward OR
- Natural gas is converted to methanol and shipped to China to be used in plastics manufacturing
- Could increase gas demand in the Northwest by 10 to 15% in region



3) NATURAL GAS PRICING



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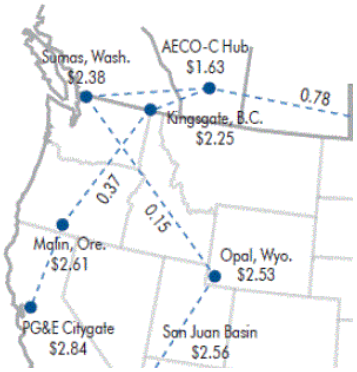
Northwest Pricing Hubs

- Sumas – Canadian border crossing, BC Pipeline to Northwest Pipeline
- AECO – the Alberta gas hub, principle hub and storage for NOVA system
- Opal – Rockies gas delivered to Northwest Pipeline



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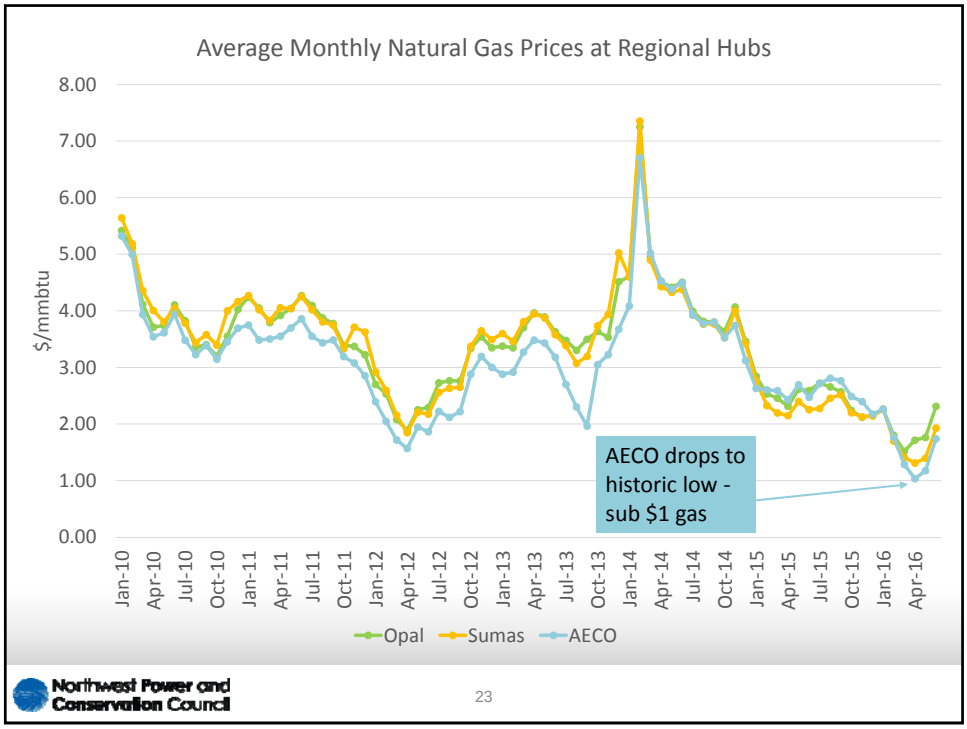
Average Monthly Natural Gas Prices at Regional Hubs
$/mmbtu
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jan-10
Apr-10
Jul-10
Oct-10
Jan-11
Apr-11
Jul-11
Oct-11
Jan-12
Apr-12
Jul-12
Oct-12
Jan-13
Apr-13
Jul-13
Oct-13
Jan-14
Apr-14
Jul-14
Oct-14
Jan-15
Apr-15
Jul-15
Oct-15
Jan-16
Apr-16
AECO drops to historic low - sub $1 gas
Opal
Sumas
AECO
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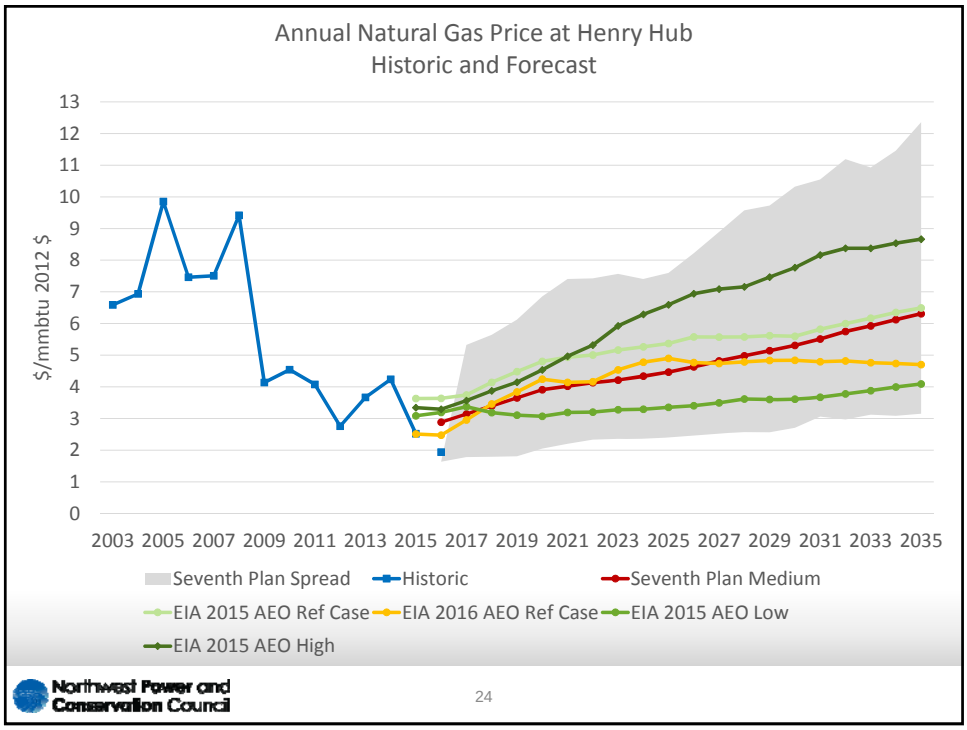
Annual Natural Gas Price at Henry Hub
Historic and Forecast
$/mmbtu 2012 $
13
12
11
10
9
8
7
6
5
4
3
2
1
0
2003 2005 2007 2009 2011 2013 2015 2017 2019 2021 2023 2025 2027 2029 2031 2033 2035
Seventh Plan Spread
Historic
Seventh Plan Medium
EIA 2015 AEO Ref Case
EIA 2016 AEO Ref Case
EIA 2015 AEO Low
EIA 2015 AEO High
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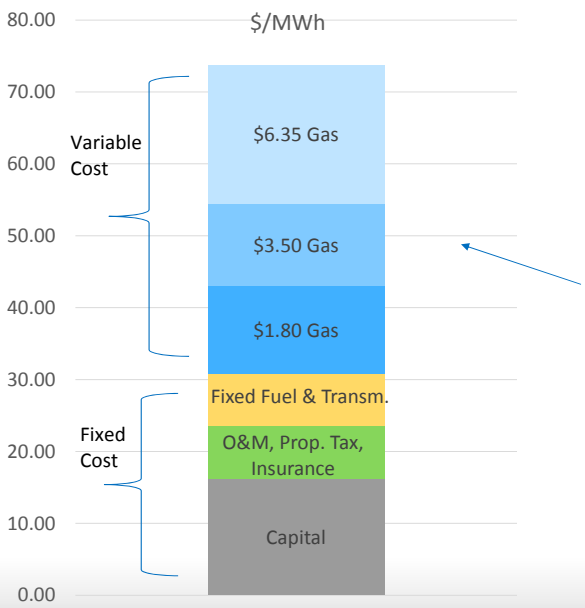

Levelized Cost Estimate $/MWh for a Combined Cycle Combustion Turbine in 2020 – when initial coal retirements are underway

Variable fuel costs are driven by natural gas prices and are a significant factor in the cost to generate electricity

Overall costs range from 74 $ at high range of gas price, down to 43 $ at low range

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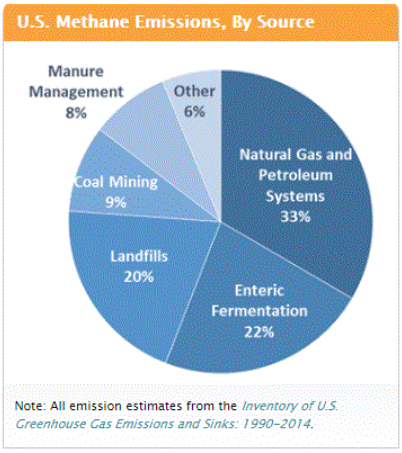

4) STORAGE & ENVIRONMENTAL ISSUES

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Gas Storage – Aliso Canyon

- Key natural gas facility for Southern California (86 Bcf) – supplies gas to 17 power plants (9800 MW) and direct use customers
- A well was discovered to be leaking gas in October 2015, was not plugged until February 2016 – 100,000 metric tons of CH4 released to atmosphere
- The facility was drawn down and taken off line and all wells are being tested

Gas Storage – Aliso Canyon

- CA state officials released a plan for reducing natural gas consumption over concerns of power outages this summer
- CAISO issued a Flex Alert June 19 over worries about the grid during a heat spell in Southern California
- The grid passed it's first challenge without Aliso Canyon – there were minor unrelated outages
- SoCalGas hopes to begin injecting gas in late summer

Environmental Policies & Regulations

- Province of Alberta to implement a Carbon Tax, and implement tighter regulation of methane leakage from oil and gas industry
- New EPA analysis and regulations on Methane
- There have been 75 studies recently published on Methane emissions as a greenhouse gas – will summarize at a later date

Summary

1. New technology has unlocked large natural gas supplies across North America
2. New supply regions have significantly altered tradition natural gas flows – the NW may be especially well positioned
3. This has resulted in stable, low prices for consumers of natural gas and affected power plant generation decisions
4. Staff will reconvene the NGAC and staff to develop a new price forecast towards the end of 2016
5. Further analysis of GHG inventory and regulations to come