Northwest **Power** and **Conservation** Council

November 7, 2017

MEMORANDUM

TO: **Power Committee**

FROM: **Steven Simmons**

SUBJECT: **An Update on the Impact of Hurricanes on Natural Gas Prices**

BACKGROUND:

Presenter: Steven Simmons, Senior Economic Analyst

Summary: Historically, Atlantic hurricanes have brought wide-spread destruction, including fatalities, to the gulf coast region of the United States. The region is highly energy intensive, and past storms have caused damage to the natural gas infrastructure resulting in severe supply disruptions. Damage from the 2005 hurricane season caused gas prices at Henry Hub to double, and high prices reverberated throughout the country. In 2008, the hurricane season caused large supply disruptions, but due to the economic recession and high levels of gas storage, the price impact was not as large. The hurricane season of 2017 has been a very active and particularly destructive one, however so far, the impact on natural gas price volatility has been minimal. It is expected that the emergence of gas production from on-shore shale would mute the impact of hurricanes on the natural gas market.

Relevance: Natural gas prices are an important component of the Council's Power Plan. The forecast of prices are used to inform many of the planning models, including AURORA$_{xmp}$, Micro-Fin, RPM, and Energy2020. Expectations around future price volatility, including modeling the potential

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impact of weather related disasters on prices, is also component of the modeling work the Council does.

Workplan: A.3 Forecasting and Economic Analysis

Background: As part of the Council's planning process, a long term forecast of natural gas prices and characterizations of price volatility is required. Last month, the natural gas price forecast was updated. Prices for the next three to five years are expected to remain relatively low and stable as a result of an abundant and diverse supply while growth in the consumption of natural gas for power generation is expected to continue as the result of low prices undercutting coal.

An Update on the Impact of Hurricanes on Natural Gas Prices

Power Committee

November 14, 2017

Steven Simmons

Northwest Power and Conservation Council

Discussion

1. Background
2. Quick overview of natural gas fundamentals covering the time period
3. The Hurricane Seasons
   a. 2005
   b. 2008
   c. 2017
4. Conclusions

Background

- Historically, hurricanes striking the Gulf Coast have caused extensive damage to the region's natural gas infrastructure.
- In the past, storm impacts on supply have reverberated across the US causing periods of extended price volatility
- The advance of onshore shale production may lesson the supply disruption of hurricanes and ring in a new era of more stable pricing
- Today we will examine the effects of three severe hurricane seasons on natural gas prices

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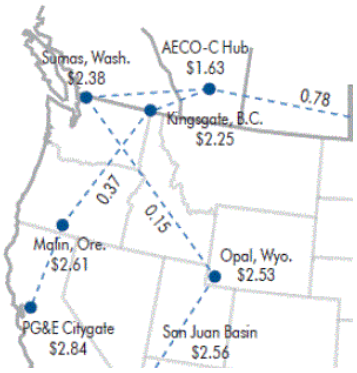

NATURAL GAS FUNDAMENTALS

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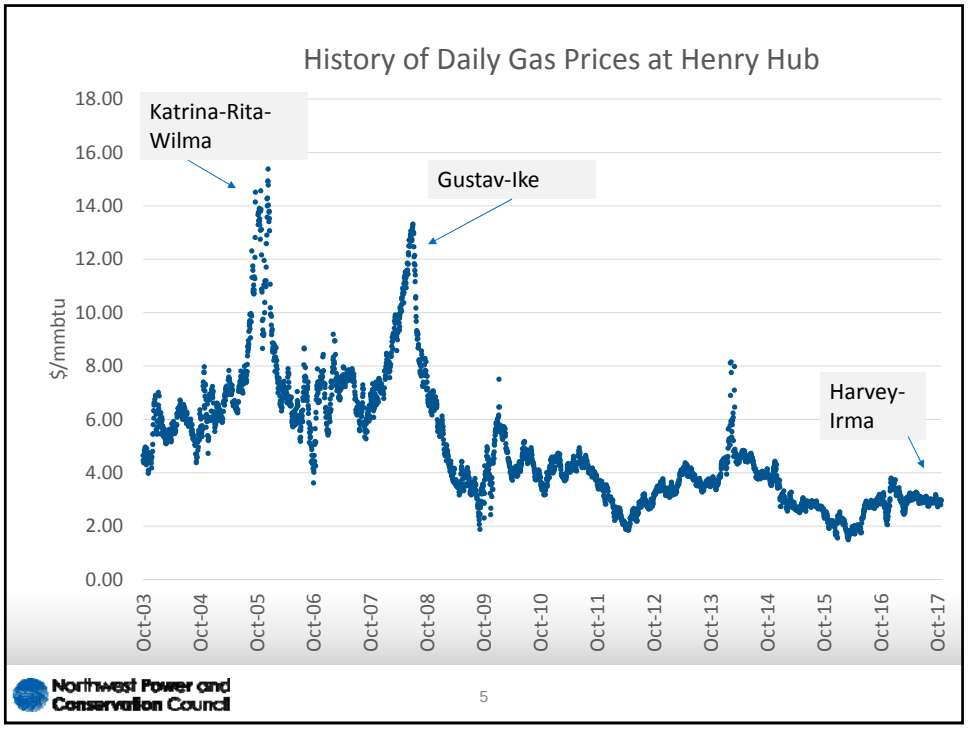
History of Daily Gas Prices at Henry Hub
Katrina-Rita-Wilma
Gustav-Ike
Harvey-Irma
$/mmbtu
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
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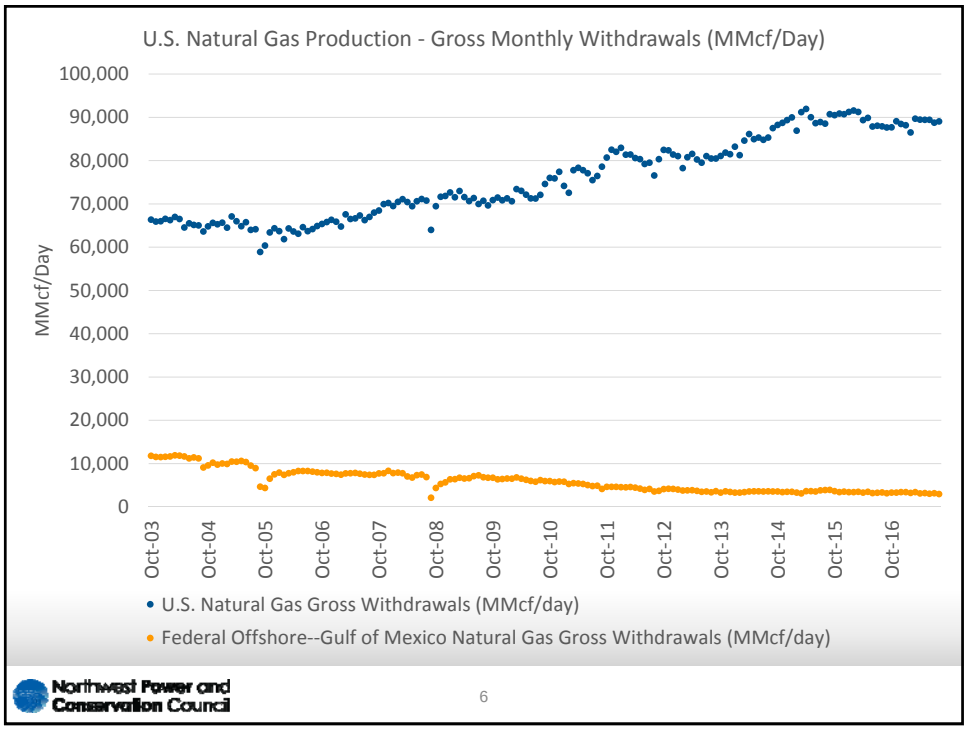
U.S. Natural Gas Production - Gross Monthly Withdrawals (MMcf/Day)
MMcf/Day
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Oct-03
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
U.S. Natural Gas Gross Withdrawals (MMcf/day)
Federal Offshore--Gulf of Mexico Natural Gas Gross Withdrawals (MMcf/day)
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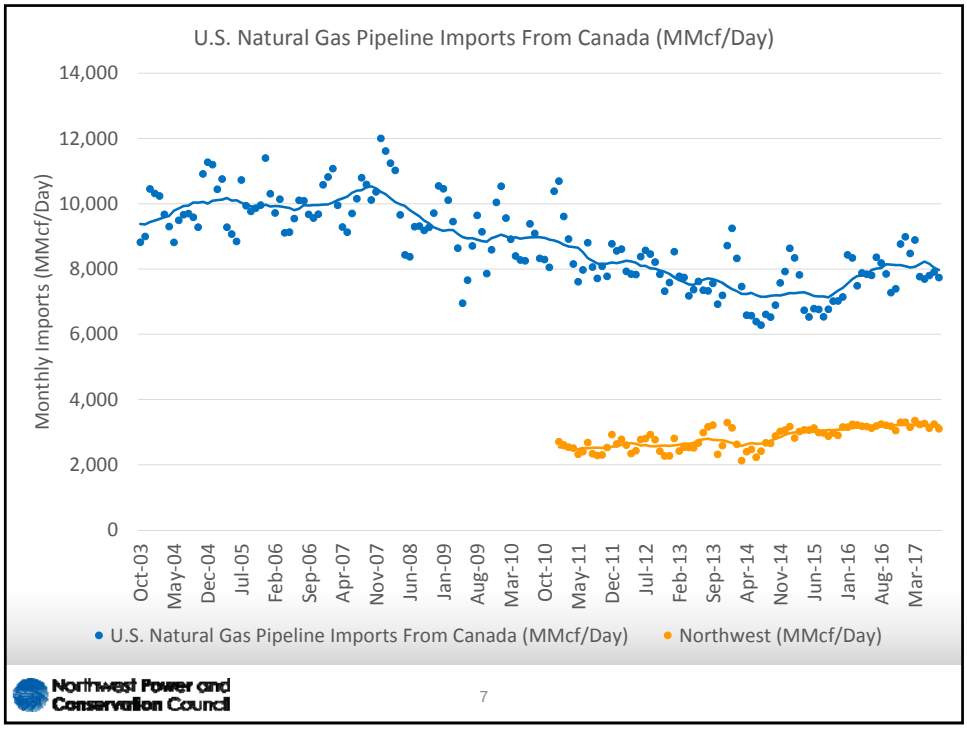
U.S. Natural Gas Pipeline Imports From Canada (MMcf/Day)
Monthly Imports (MMcf/Day)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Oct-03
May-04
Dec-04
Jul-05
Feb-06
Sep-06
Apr-07
Nov-07
Jun-08
Jan-09
Aug-09
Mar-10
Oct-10
May-11
Dec-11
Jul-12
Feb-13
Sep-13
Apr-14
Nov-14
Jun-15
Jan-16
Aug-16
Mar-17
U.S. Natural Gas Pipeline Imports From Canada (MMcf/Day)
Northwest (MMcf/Day)
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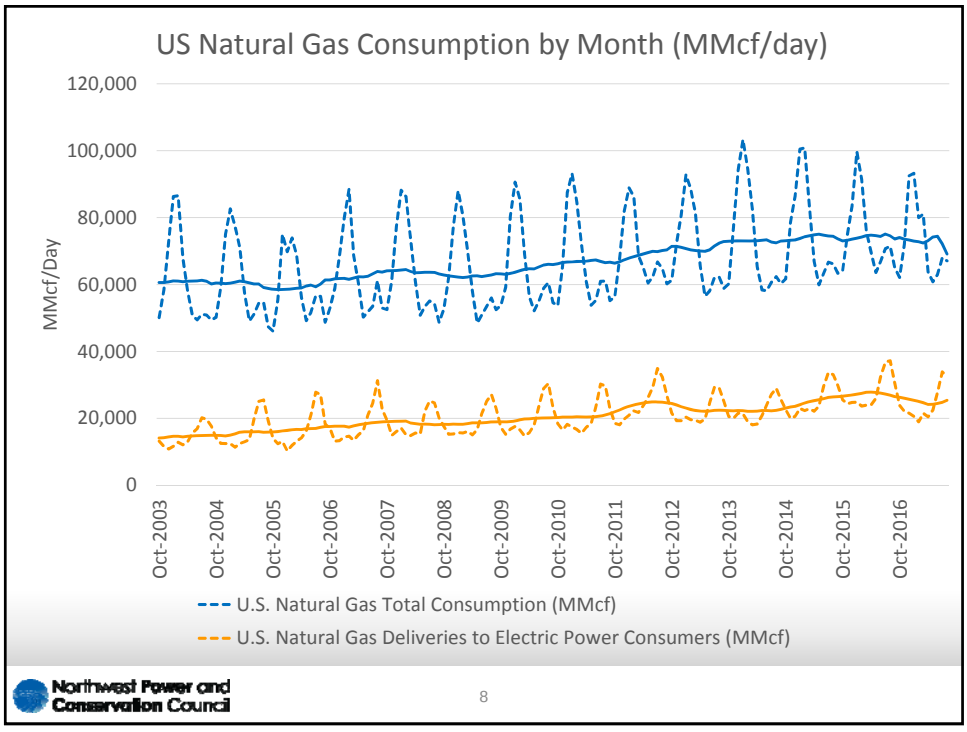
US Natural Gas Consumption by Month (MMcf/day)
MMcf/Day
120,000
100,000
80,000
60,000
40,000
20,000
0
Oct-2003
Oct-2004
Oct-2005
Oct-2006
Oct-2007
Oct-2008
Oct-2009
Oct-2010
Oct-2011
Oct-2012
Oct-2013
Oct-2014
Oct-2015
Oct-2016
U.S. Natural Gas Total Consumption (MMcf)
U.S. Natural Gas Deliveries to Electric Power Consumers (MMcf)
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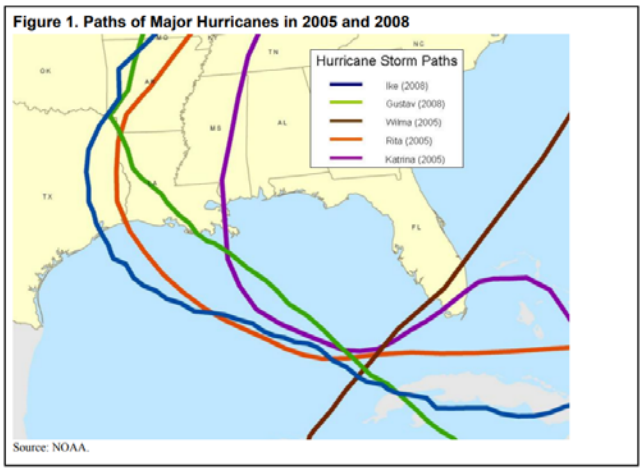

2005 HURRICANE SEASON

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2005 Hurricane Season

1. The most active Atlantic hurricane season in recorded history
   a. Katrina (August 23 – 31)
   b. Rita (September 18 – 26)
   c. Wilma (October 16 – 27)
2. At the time leading up to the season – Gulf Coast offshore production comprised nearly 20% of overall US production
3. Much of the offshore supply was lost for an extended period. Some never recovered. Also processing facilities and pipeline segments were damaged or destroyed.
4. About 10% of the overall US gas production was taken off line causing supply-demand pressures
5. Henry Hub prices doubled and high natural gas prices spread across the country

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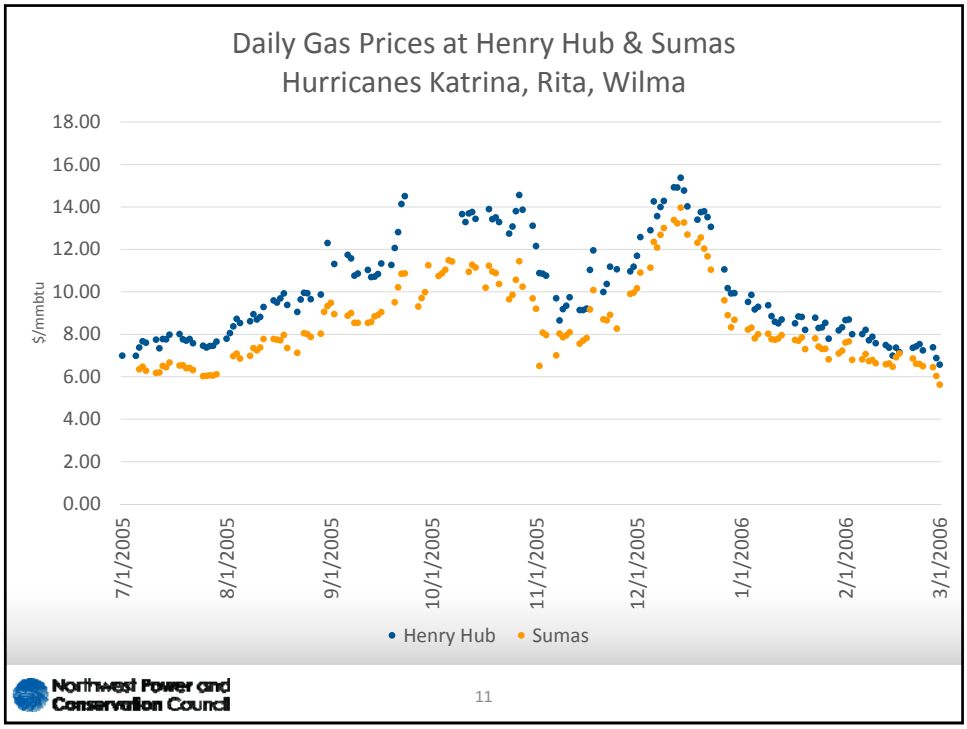

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2008 HURRICANE SEASON

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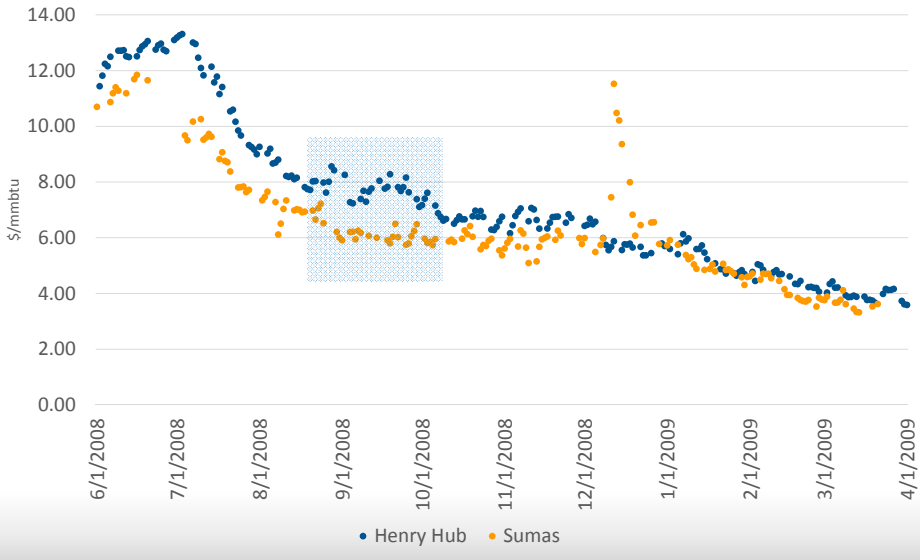
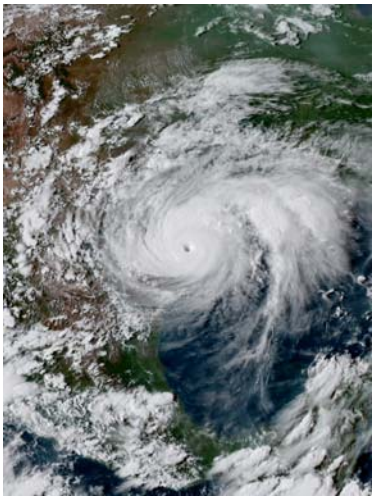
2008 Hurricane Season

1. The 5th most costly Atlantic hurricane season
   a. Gustav (August 25 – September 7)
   b. Ike (September 1 – 15)
2. At the time leading up to the season – Gulf Coast offshore production comprised nearly 11% of overall US production
3. Again much of the offshore supply was lost for an extended period and overall US supply did briefly drop by around 9%
4. However Henry Hub prices were not significantly affected as in 2005 – why not?



2008 Hurricane Season & Prices

1. There was a big run-up of natural gas prices during 2008 prior to the hurricanes
   a. Expectation that demand would exceed supply, even though production was strong
   b. Oil prices rose to $140 per barrel – was thought that global LNG priced in oil-equivalents was setting marginal gas price
2. Working gas in storage was at a high level prior to the hurricane season due to a mild winter – cushioning the loss of production
3. The economy then cratered, taking gas prices with it



2017 HURRICANE SEASON

2017 Hurricane Season

1. The highest number of major hurricanes since 2005
   a. Harvey (August 17 – September 3)
   b. Irma (August 30 – September 16)
2. Today offshore production in the gulf coast region comprises under 4 % of total US production
3. Offshore production was taken off-line, and onshore Eagle Ford shale was also shut-in, but all production came back on-line fairly soon
4. Henry Hub prices were seemingly not affected

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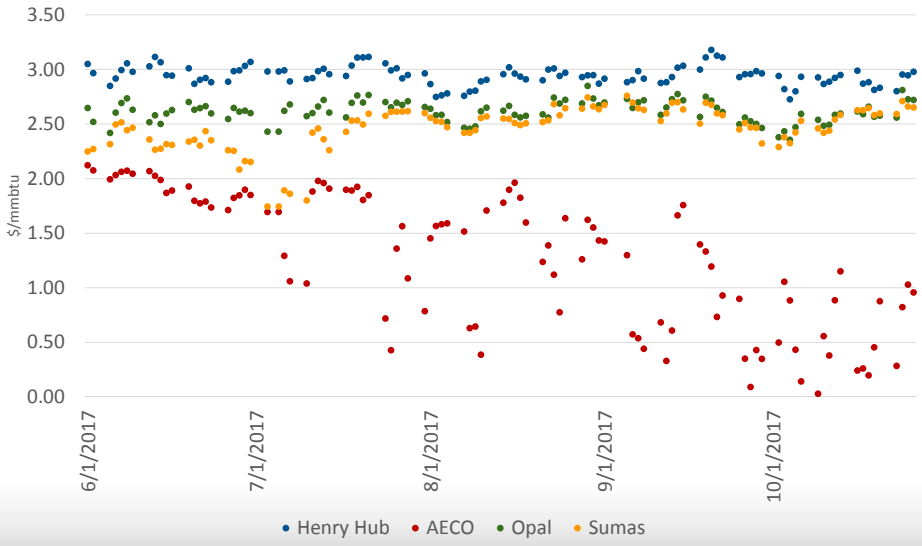
Daily Gas Prices at Henry Hub, AECO, Opal & Sumas
Hurricanes Harvey, Irma



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2017 Hurricane Season

1. Demand destruction
   a. Ports along the coast suffered varying degrees of damage and were closed to incoming ships – including the Sabine Neches waterway. Natural gas intake at the Sabine Pass LNG export terminal dropped by more than half.
   b. Refineries were flooded, many of which use gas in processing

Electricity Impacts

Hurricane	Millions of Customers without Power (Worst Day)
Katrina (2005)	2.7
Rita (2005)	1.5
Wilma (2005)	3.5
Gustav (2008)	1.1
Ike (2008)	3.9

From US Department of Energy, February 2009, on the impacts of the 2005 and 2008 hurricanes on US energy infrastructure

- Prime cause of electricity outages in 2005 & 2008 due to damaged T&D systems
- Power outages in 2005 and 2008 were not due to power plant closings from the storm – some nuclear plants were shutdown in advance and brought back to service

Conclusions

- There is a general feeling that we are in a more stable pricing environment with shale
- Hurricane damage may have less of an upward price impact – may cause more demand destruction than supply destruction.
- Future volatility in the Northwest may be more regionally (West) driven – winter "freeze offs", potential chronic pipeline capacity issues, unexpected loss of storage (Aliso Canyon)