

Long-term Natural Gas Price Forecast

June 7th 2013



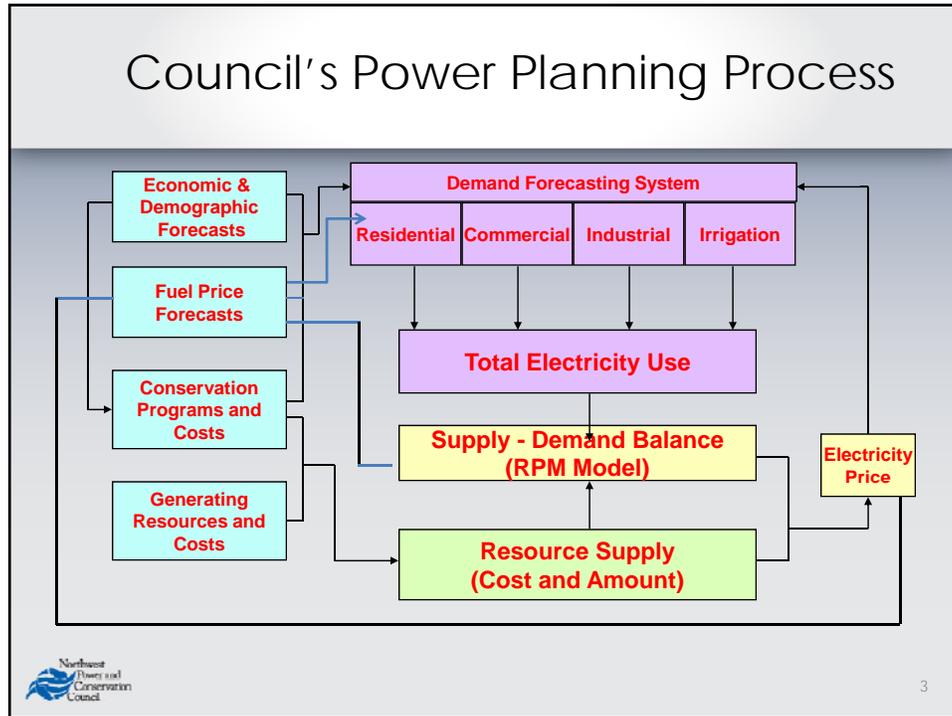
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Draft Agenda

- Welcome and introductions 9:00 to 9:15
- Council's modeling overview and use of forecasts
- Northwest Gas Outlook –(NWNGA) 9:15 to 9:45
- Shale Gas- alternative scenarios (CEC) 9:45 to 10:15
- NAMgas model- (CEC) 10:15 to 10:45
- Draft Environmental Costs 10:45 to 11:00
- Break
- Straw man proposal 7th plan forecast prices 11:10 to 12:00
 - Result of fuel price poll
 - Comparison to other forecasts
- Council's Portfolio Model 12:00 to 12:20
- Next steps 12:20 to 12:30

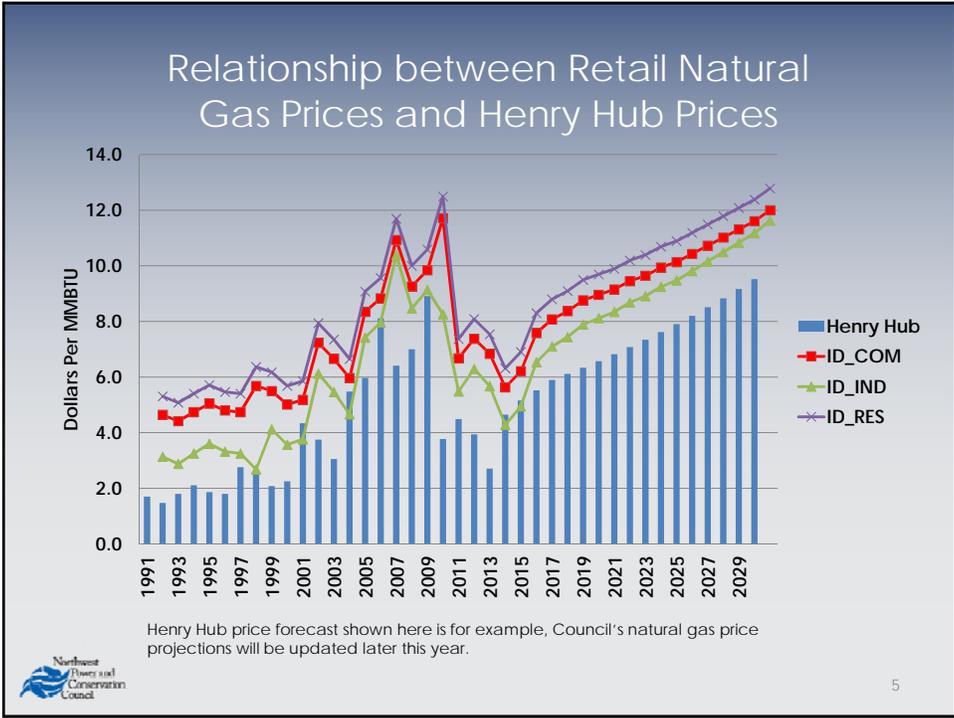


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How HH price forecast is used

- **Demand Forecast**
 - Direct Calculation of Retail natural gas Rates
- **Electricity Price Forecast**
 - Direct Calculation of burner-tip prices for power plants.
- **Resource Portfolio Selection**
 - Stochastically Used in setting expected values for natural gas market price excursions.



Comparison of Forecast and Actual 2012 (2012\$)

	Henry Hub Price Natural Gas Forecast 2012\$/mmbtu	PRB Coal Prices 2012\$/mmbtu	Refiners Acquisition Cost Forecast 2012\$/Barrel
Low	\$2.4	0.79 \$0.78 Actual	\$85
Med-Low	\$2.5	\$0.80	\$90
Medium	\$2.6	\$0.82	\$95
Med-High	\$2.7 \$2.66 Actual ←	\$0.83	\$98
High	\$2.7	\$0.84	\$105 \$101 Actual

Except for coal, all fuel prices were within forecasted range

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2013 NWGA Outlook Overview

Natural Gas Advisory Committee
June 7, 2013
Portland, OR

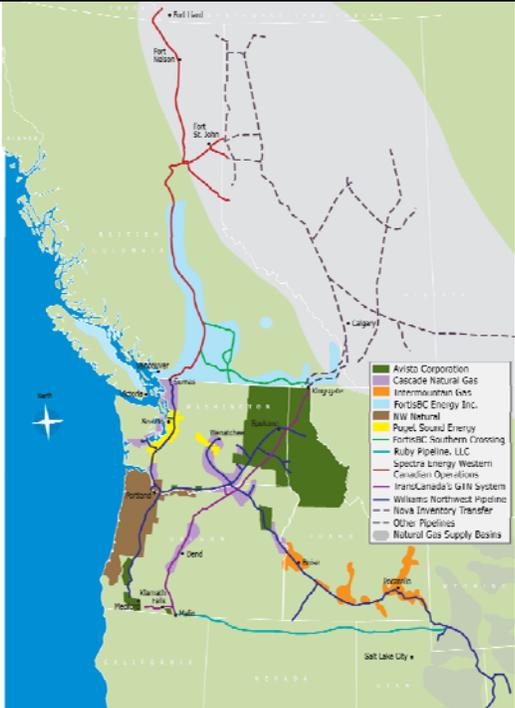


**NWGA**
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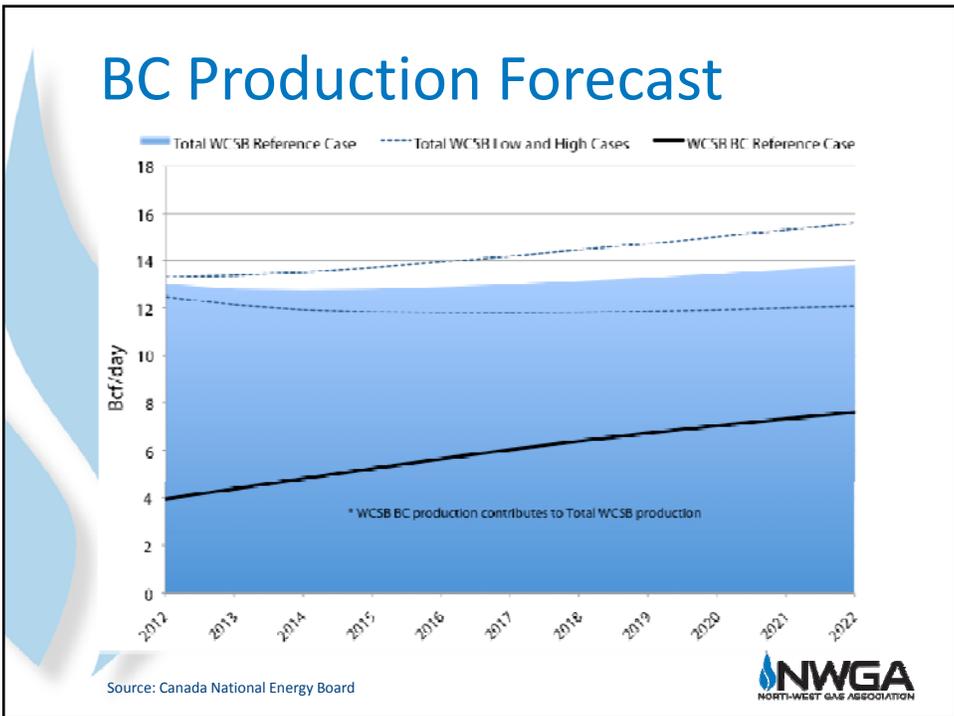
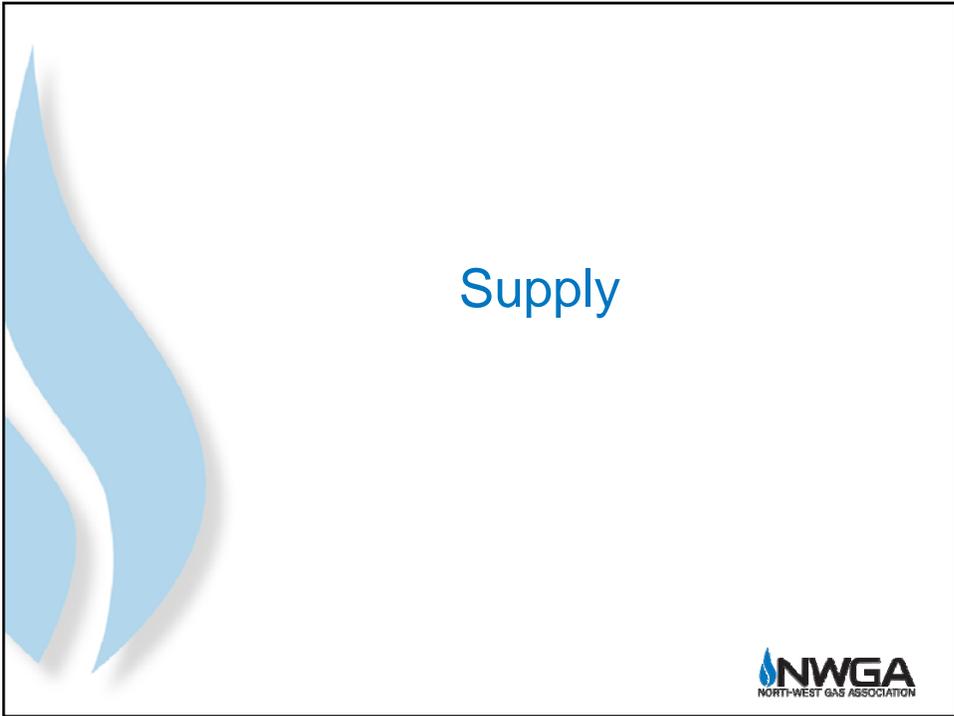
NWGA Members:

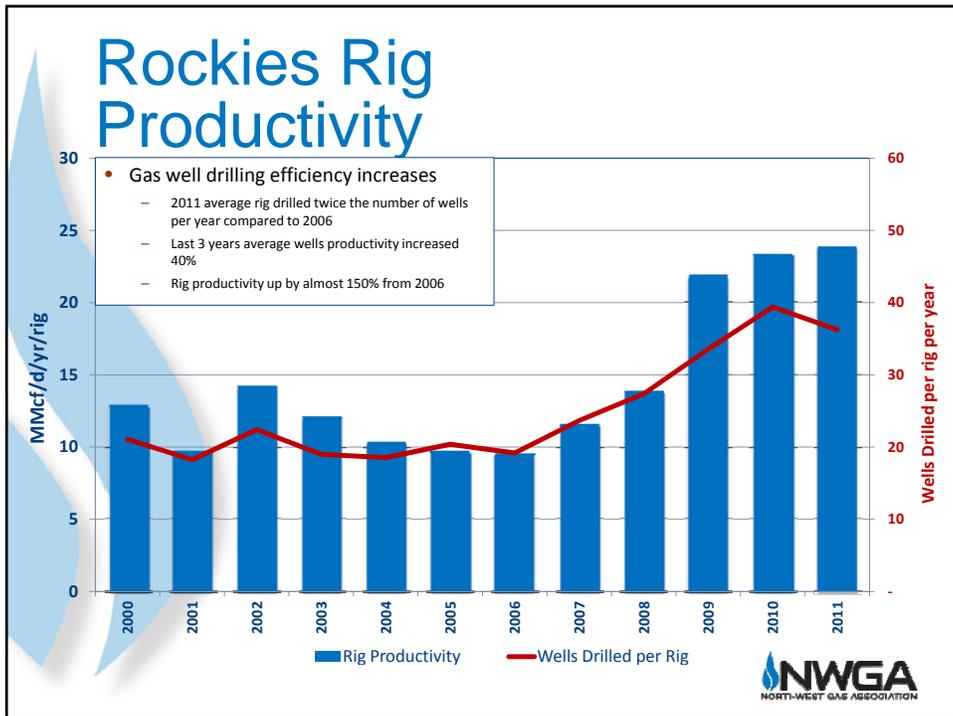
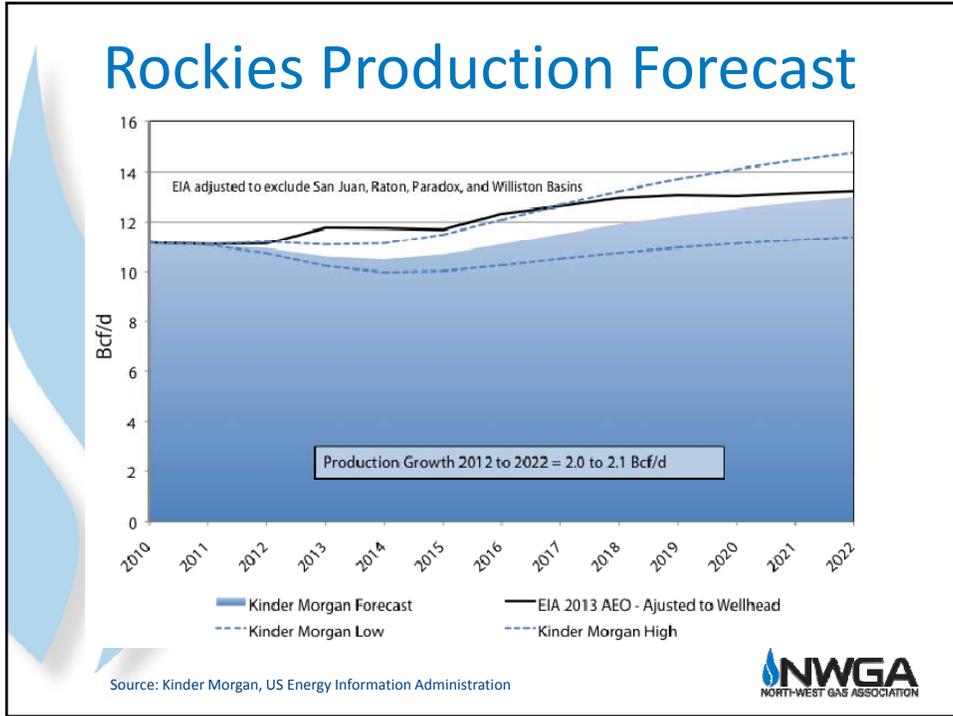
- Avista Corporation**
- Cascade Natural Gas Co.**
- FortisBC Energy**
- Intermountain Gas Co.**
- NW Natural**
- Puget Sound Energy**
- Kinder Morgan Ruby Pipeline**
- Spectra Energy Transmission**
- TransCanada GTN System**
- Williams NW Pipeline**



Legend:

- Avista Corporation
- Cascade Natural Gas
- Intermountain Gas
- FortisBC Energy Inc.
- NW Natural
- Puget Sound Energy
- FormisAC Southern Crossing
- Ruby Pipeline, LLC
- Spectra Energy Western Canadian Operations
- TransCanada's GTN System
- Williams Northwest Pipeline
- North Inventory Transfer
- Other Pipelines
- Natural Gas Supply Basins



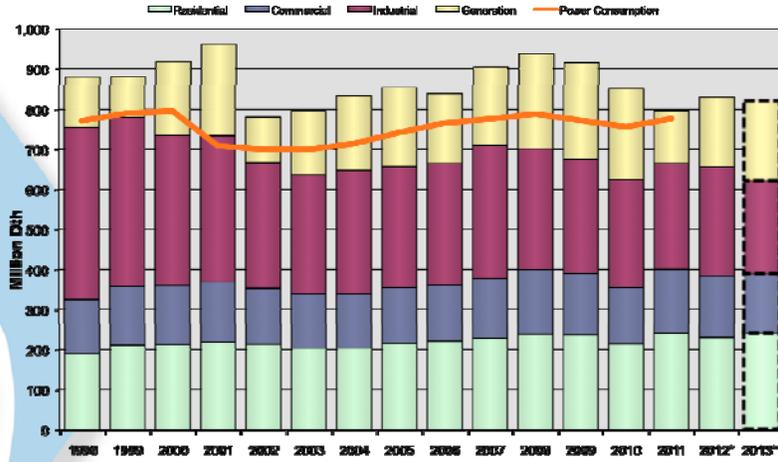


Demand



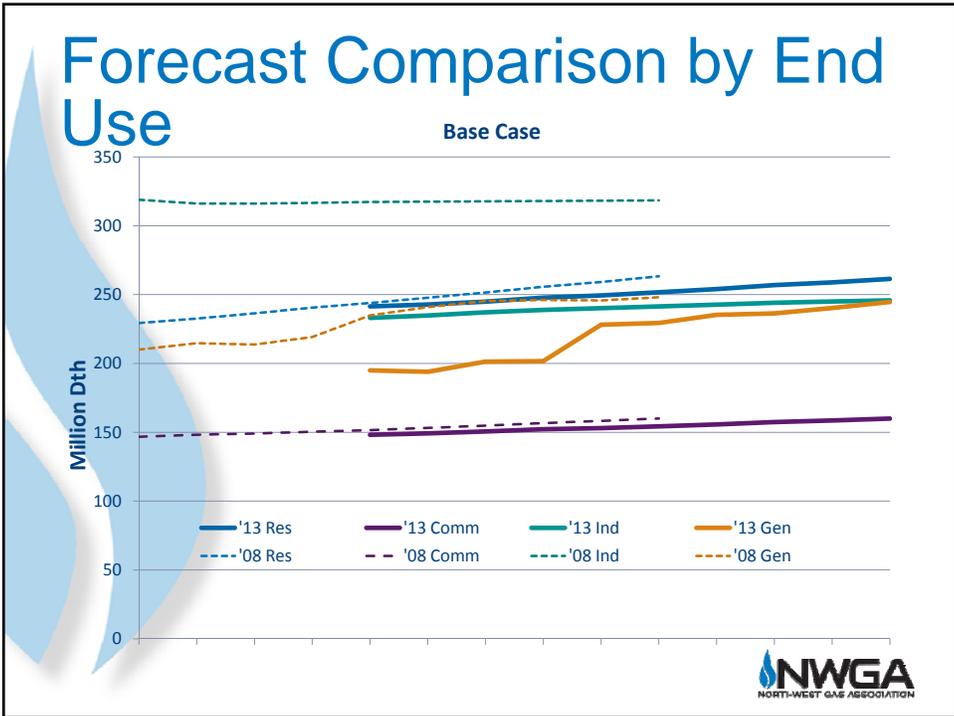
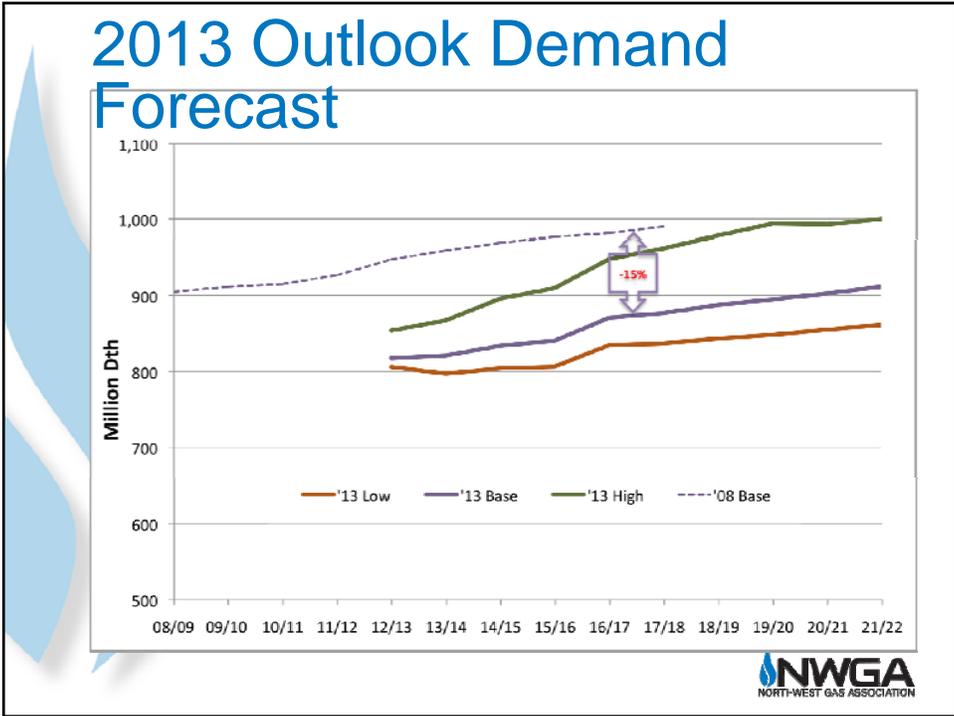
Recent Gas Demand

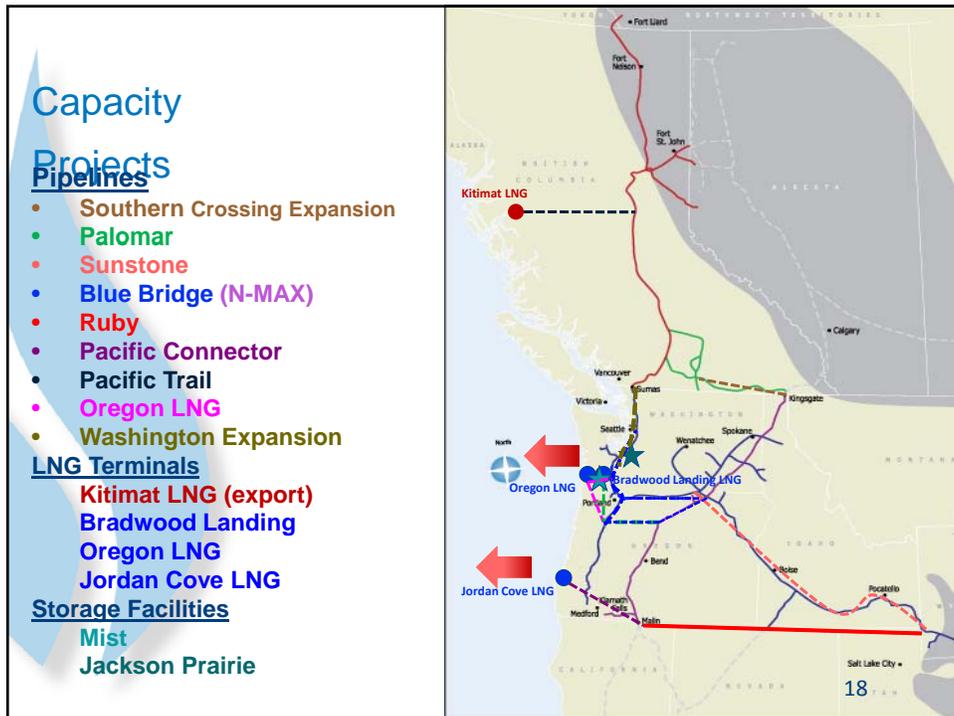
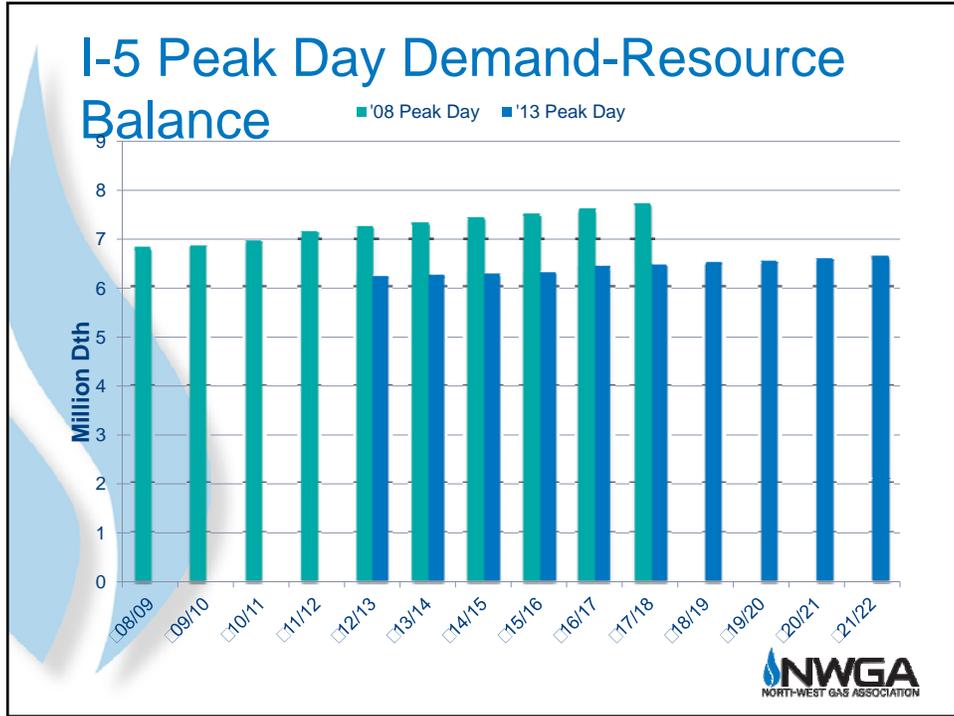
PNW Gas Deliveries (source: US EIA, StatCan, 2013 Outlook)

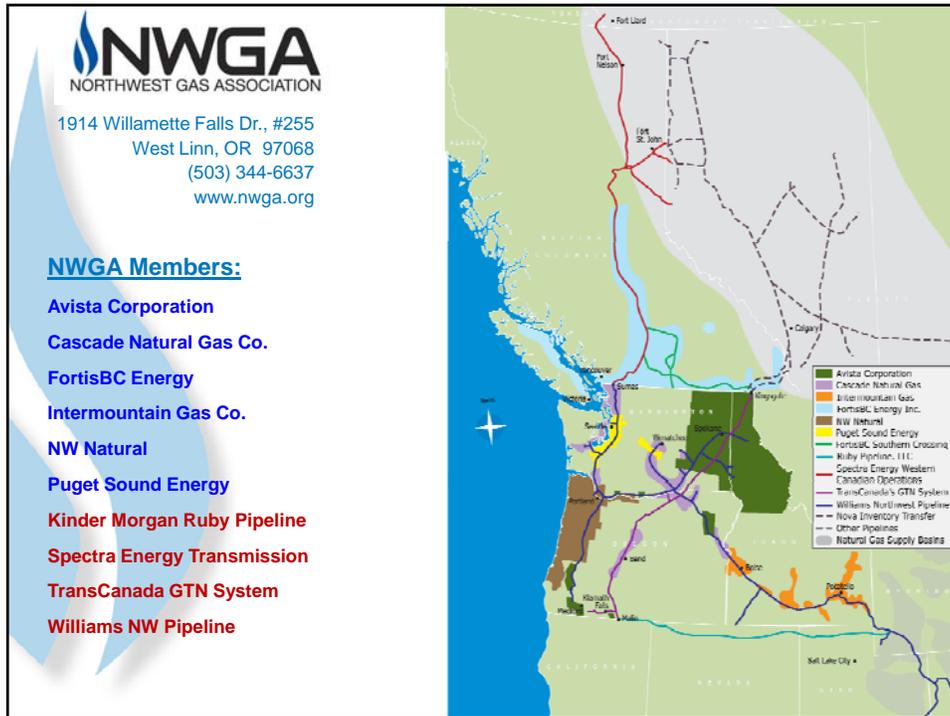


* Estimated US: December, Canada Q4
** 2013-2019 Forecast











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North American Market Gas-Trade (NAMGas) Model: Updated Common Cases

Northwest Power and Conservation Council
Natural Gas Advisory Committee

June 7, 2013

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Electricity Analysis Office
Electricity Supply Analysis Division
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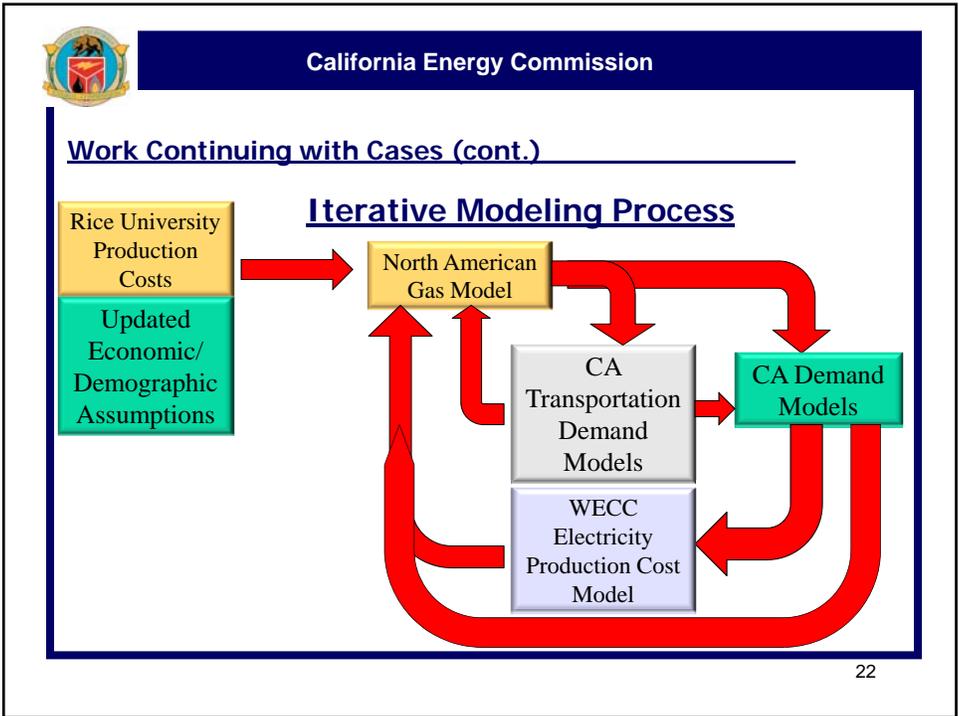


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Work Continuing with Cases

- **February 19th IEPR Workshop**
 - NAMGas Model – Leon Brathwaite
 - Iterative Modeling Process – Ivin Rhyne
 - Stakeholders' comments and suggestions

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**Reference Case:
Changes Made from February 19th Assumptions**

- **Coal Fired Generation Retirement:**
 - 30 GW starting in 2014 => 61 GW starting in 2014
 - The Brattle Group - October, 2012
- **Renewable Portfolio Standard:**
 - California meets RPS on time, 5 year delay for other states => California and rest of WECC states meet RPS on time, 5 year delay elsewhere
- **Updated Infrastructure Capacity Addition to Export Natural Gas to Mexico**
- **Added Structure to Improve Performance of the LNG Sector**
 - Conversion from WGTM to NAMGas

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**High Price/Low Demand Case:
Changes Made from February 19th Assumptions**

- **Cost Environment:**
 - P50 Line => P10 Line
- **Updated Infrastructure Capacity Addition to Export Natural Gas to Mexico**
- **Added Structure to Improve Performance of the LNG Sector**
 - Conversion from WGTM to NAMGas

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**Low Price/High Demand Case:
Changes Made from February 19th Assumptions**

- **Cost Environment:**
 - P50 Line => P90 Line
- **Coal Fired Generation Retirement:**
 - 1 GW starting in 2014 => 31 GW starting in 2014
 - The Brattle Group - October, 2012
- **Updated Infrastructure Capacity Addition to Export Natural Gas to Mexico**
- **Added Structure to Improve Performance of the LNG Sector**
 - Conversion from WGTm to NAMGas

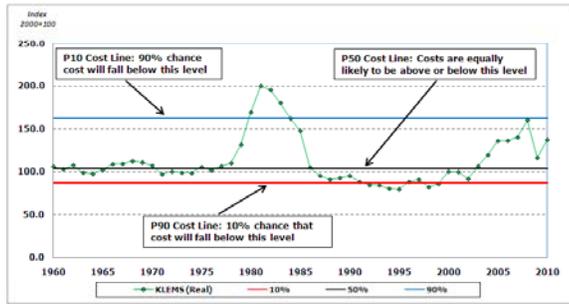
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**North American Market Gas Trade Model:
Developing a Cost Environment**

Typical Cost Environment (P50): 1975, 1986, and 2003



- **Staff must simulate the cost environment for analysis:**
 - Graph shows indexed cost between 1960 and 2010
 - High cost environment ~ 1979 – 1984
 - Low cost environment ~ 1992 – 2000.

Sources: Baker Institute.

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Common Cases:
Supply Balance

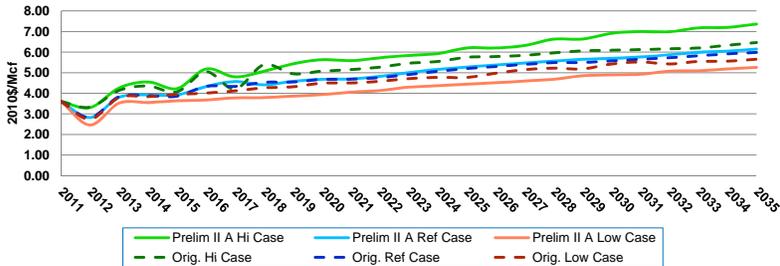
**Performance of Cases:
Lower 48**

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Common Cases:
Price Performance of Cases (Henry Hub)

Henry Hub Prices



Year	Prelim II A Hi Case	Prelim II A Ref Case	Prelim II A Low Case	Orig. Hi Case	Orig. Ref Case	Orig. Low Case
2011	3.5	3.5	3.5	3.5	3.5	3.5
2012	4.0	3.5	3.0	4.0	3.5	3.0
2013	4.5	3.5	3.0	4.5	3.5	3.0
2014	4.5	3.5	3.0	4.5	3.5	3.0
2015	5.0	3.5	3.0	5.0	3.5	3.0
2016	5.5	3.5	3.0	5.5	3.5	3.0
2017	5.5	3.5	3.0	5.5	3.5	3.0
2018	5.5	3.5	3.0	5.5	3.5	3.0
2019	5.5	3.5	3.0	5.5	3.5	3.0
2020	5.5	3.5	3.0	5.5	3.5	3.0
2021	5.5	3.5	3.0	5.5	3.5	3.0
2022	5.5	3.5	3.0	5.5	3.5	3.0
2023	5.5	3.5	3.0	5.5	3.5	3.0
2024	5.5	3.5	3.0	5.5	3.5	3.0
2025	5.5	3.5	3.0	5.5	3.5	3.0
2026	5.5	3.5	3.0	5.5	3.5	3.0
2027	5.5	3.5	3.0	5.5	3.5	3.0
2028	5.5	3.5	3.0	5.5	3.5	3.0
2029	5.5	3.5	3.0	5.5	3.5	3.0
2030	5.5	3.5	3.0	5.5	3.5	3.0
2031	5.5	3.5	3.0	5.5	3.5	3.0
2032	5.5	3.5	3.0	5.5	3.5	3.0
2033	5.5	3.5	3.0	5.5	3.5	3.0
2034	5.5	3.5	3.0	5.5	3.5	3.0
2035	5.5	3.5	3.0	5.5	3.5	3.0

- In general, prices behave as expected:
 - High Price case produced highest prices
 - Low price case produced lowest prices
- Adjusted cases have created a larger “zone of uncertainty”

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National Cases:
Price Performance of Cases (Differentials)

Topock - Henry Hub

Topock-Henry Hub Price Differential

- **In general, differentials turn positive after 2013:**
 - Resource abundance more evident in the eastern US
 - Access to shale and 'tight' gas resources is re-ordering the supply portfolio, impacting eastern prices more than western.

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Common Scenarios Cases:
Supply Portfolio of Reference Case (2025)

Canadian Imports: 13.3 Bcf/d

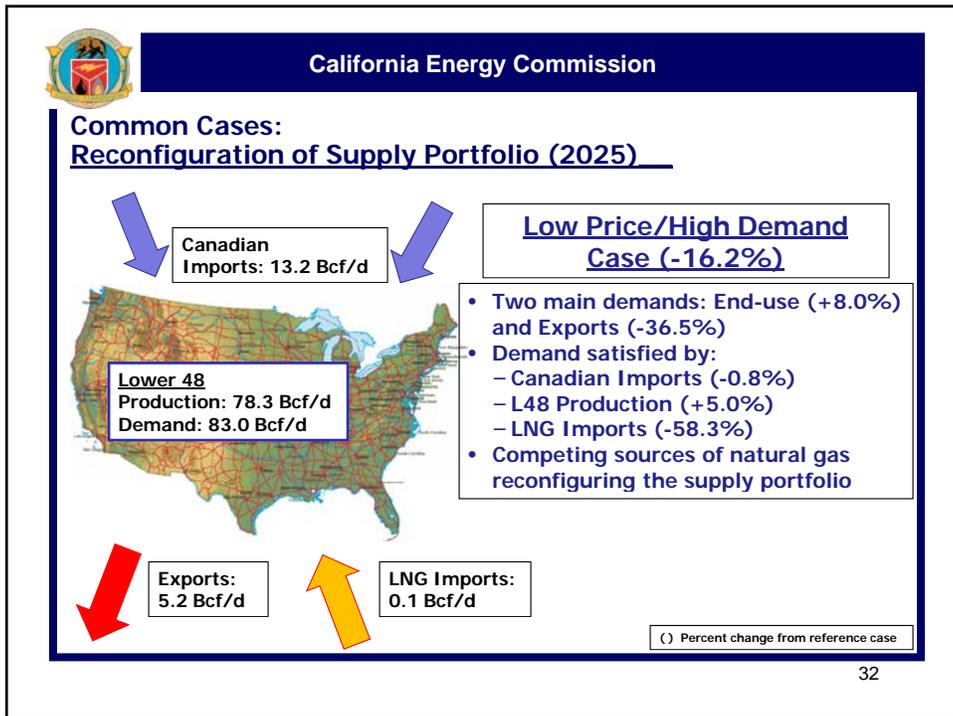
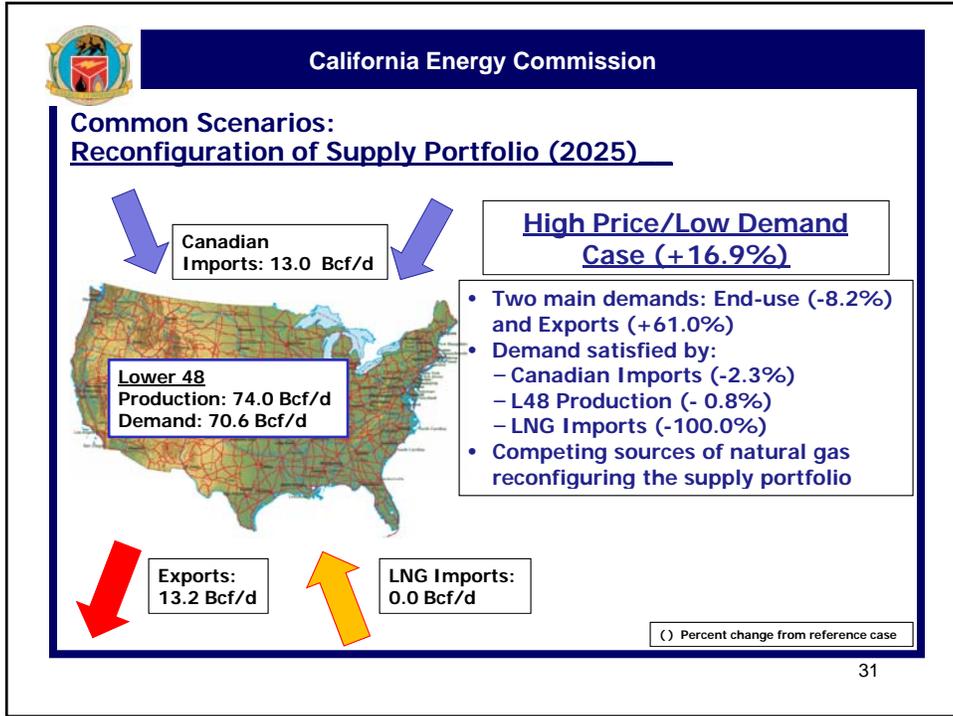
Lower 48
 Production: 74.6 Bcf/d
 Demand: 76.9 Bcf/d

Exports: 8.2 Bcf/d

LNG Imports: 0.24 Bcf/d

- Two main demands: End-use and Exports
- Demand satisfied by:
 - Canadian Imports
 - L48 Production
 - LNG Imports

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**Common Cases:
Supply Balance**

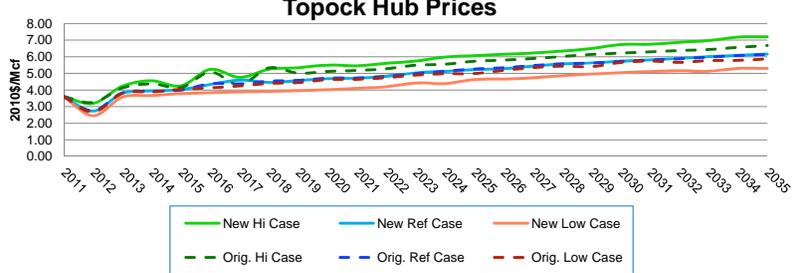
**Performance of Cases:
California**

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**Common Cases:
Price Performance of Cases (Topock Hub)**

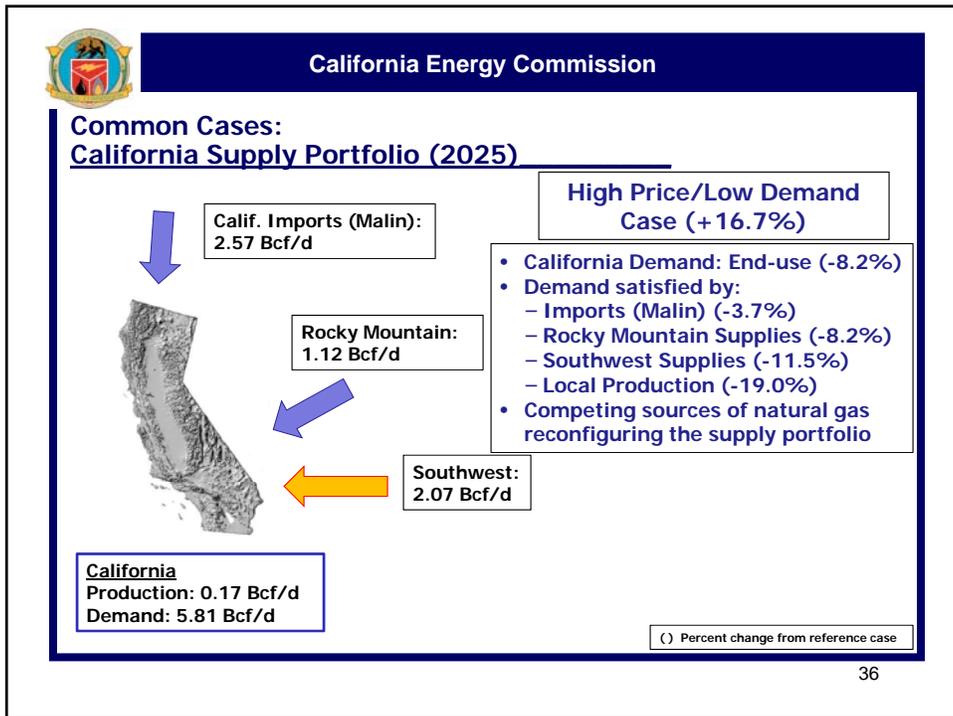
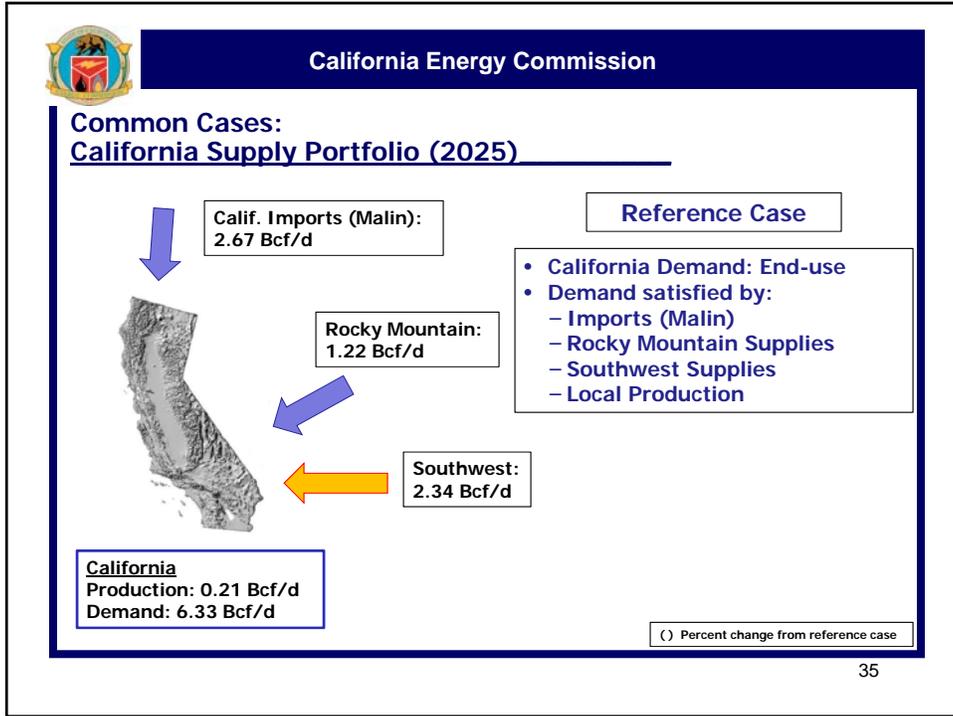
Topock Hub Prices

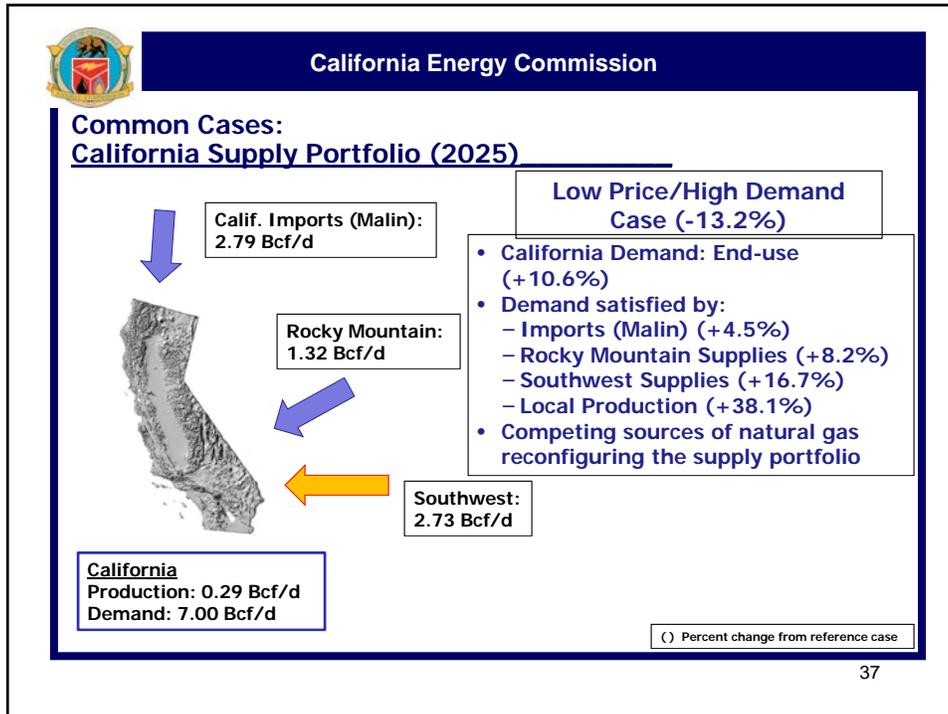


• **In general, prices behave as expected:**
– High Price case produced highest prices
– Low price case produced lowest prices

• **The adjusted cases creates a larger “zone of uncertainty” for California.**

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- California Energy Commission**
- Summary:**
- Work Ongoing with Cases
 - Modeling Iterative Process still ongoing
 - More Stakeholders suggestions and comments expected
 - Larger Zone of Uncertainty
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Assessing Uncertainty on Shale Production



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Shale Production Uncertainty Cases: A Scenario Examination

Northwest Power and Conservation Council
Natural Gas Advisory Committee Meeting

June 07, 2013

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Shale Production Uncertainty Scenario Cases: Brief Background

- **In the last ten years, the development of natural gas resources from shale formations has generated much controversy:**
 - The potential for groundwater contamination
 - The possibility of increased seismic activity
 - The diversion of freshwater used in hydraulic fracturing
 - The possibility of added methane emissions.

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Shale Production Uncertainty Scenario Cases: Brief Background (cont'd)

- Decision-makers are re-examining policies related to the development of these resources:
 - Some jurisdictions such as New York have delayed the development of its shale resources
 - Others have instituted environmental impact fees
 - Others are tightening regulation of hydraulic fracturing
- Technological innovation has accelerated in the natural gas industry
- Natural gas from shale formations occupy larger share of total Lower 48 production
 - In April 2013, shale formations produced 30.6 bcf/d
 - Production represents about 40% market share.

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Shale Production Uncertainty Scenario Cases: What are the Shale Production Uncertainty Cases?

- The development of shale formations is transforming the natural market
- Four Scenario Cases will explore impact:
 - Shale Abundance
 - Shale Reconsidered
 - Shale Expensive
 - Shale Deferred

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Shale Production Uncertainty Scenario Cases: Key Variables

- Variations in four key variables:
 - Changes in the supply cost curves
 - Changes in the time of availability of some resources
 - Changes in environmental impact fees
 - Changes in the rate of growth of technological innovation
- Changes relative to the reference case.

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Shale Production Uncertainty Scenario Cases: Shale Abundance

- **Shale Abundance:**
 - Begins with the Reference Case
 - **Supply Cost Curves ~**
 - Expanded resource base
 - All known shale formations developed
 - Current estimates 15% low; lead to upward adjustment of curves
 - **Availability ~ No delay in production hook-ups**
 - **Environmental Impact Fees/O &M ~ Impact fees and water handling cost at low end of range: \$0.30/Mcf**
 - **Technology & Innovation ~ Technology grows at 2.5%.**

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Shale Production Uncertainty Scenario Cases: Shale Reconsidered

- **Shale Reconsidered:**
 - Begins with the Reference Case
 - **Supply Cost Curves ~**
 - Concerns about hydraulic fracturing delay further development of shale formations
 - Targeted moratorium on new drilling into shale formations
 - Resource base shrinks by 15%
 - **Availability ~ Hookup of new production faces significant environmental challenges; delays run about 3 years**
 - **Environmental Impact Fees/O &M ~ Impact fees and water handling cost at high end of range: \$0.55/Mcf**
 - **Technology & Innovation ~ Technology grows at 1.0%.**

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Shale Production Uncertainty Scenario Cases: Shale Expensive

- **Shale Expensive:**
 - Begins with the Reference Case
 - **Supply Cost Curves**
 - Resource base unchanged from the reference case
 - **Availability ~ Hookup of new production faces significant environmental challenges; delays run about 3 years**
 - **Environmental Impact Fees/O &M ~ Environmental impact fees in many jurisdictions are 20% higher than high end cost, reaching \$0.67/Mcf**
 - **Technology & Innovation ~ Technology grows at 0.5%.**

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Shale Production Uncertainty Scenario Cases: Shale Deferred

- **Shale Deferred:**
 - Begins with the Reference Case
 - **Supply Cost Curves ~**
 - Resource base unchanged from the reference case
 - **Availability ~ Hookup of new production faces significant environmental challenges; delays run 3 - 5 years**
 - **Environmental Impact Fees/O &M ~ Impact fees and water handling cost at high end of range at \$0.55/Mcf**
 - **Technology & Innovation ~ Technology grows at 1.0%.**

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Shale Production Uncertainty Scenario Cases:
Final

Questions & Comments

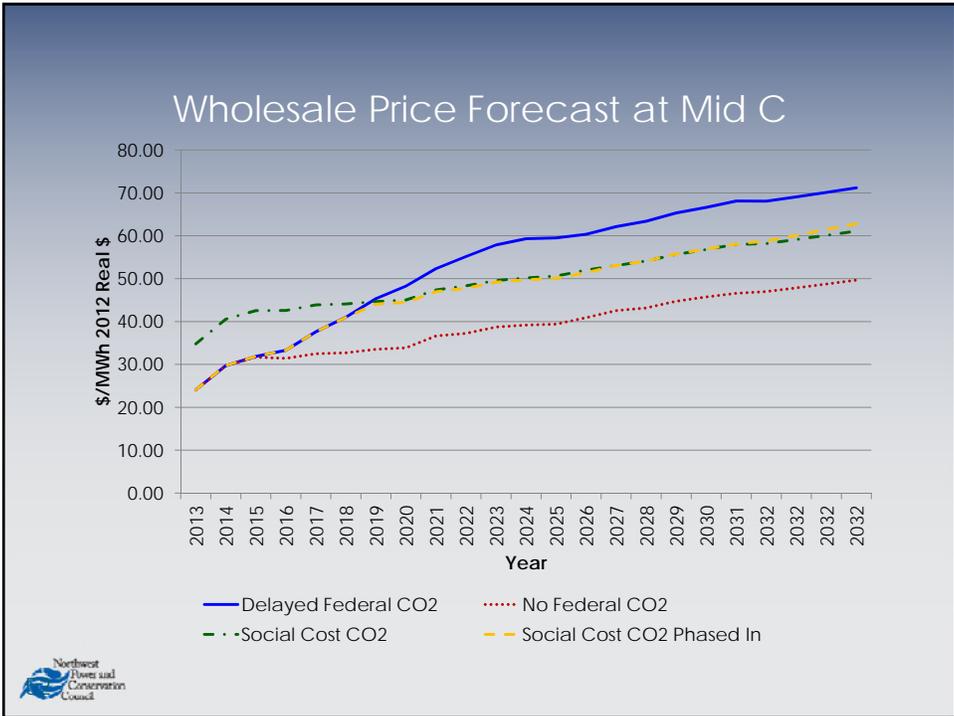
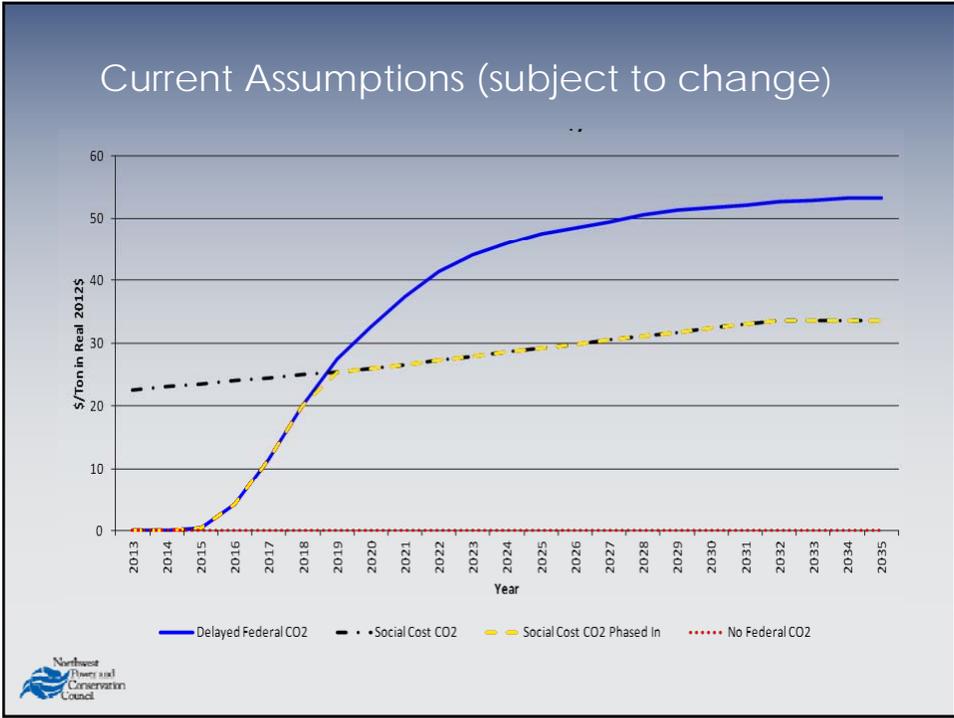
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CO2 Costs (draft)

- CO2 Cost is incorporated in estimates of the retail rates costs that consumers see.
- CO2 costs are also incorporated in calculation of wholesale electricity prices.
- CO2 costs are also incorporated in resource selection process in Council's Portfolio model.
- Steve Simmons will talk about range of CO2 costs.



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Straw Man Proposal for Preliminary Seventh Plan Forecast of Prices



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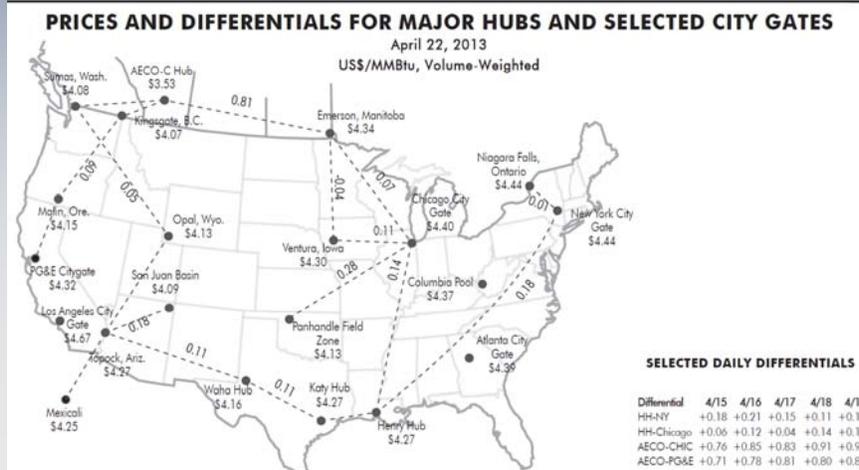
Background

- In the past three years we have seen major changes:
- In the 2011 update, we lowered our long-term forecast of natural gas prices to reflect structural changes in the natural gas supply picture (*due to technological changes such as hydraulic fracturing , horizontal drilling, and natural gas from shale formations.*)
- In 2012, we provided a lower short-term price forecast for the 2012-2015 period while maintaining long-term price forecast for 2016-2030
- In this year's forecast we raised short-term price forecast and narrowed the forecast range.



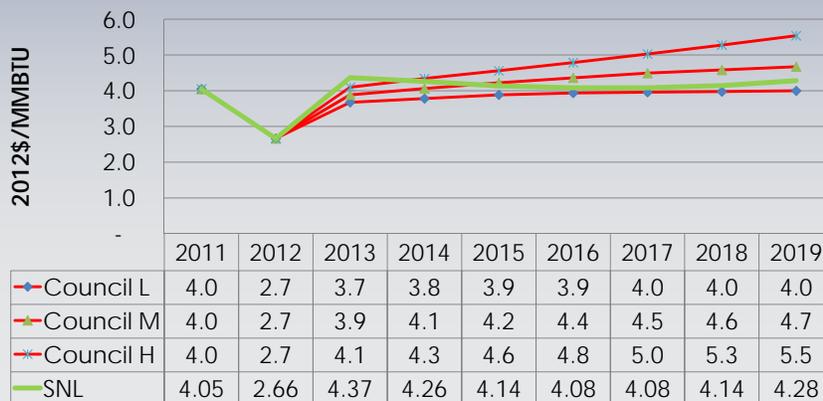
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By April 2013 prices were over \$4.



Natural Gas Strawman Proposal compared to short-term prices from SNL Annual Strip (as of May 1, 2013)

Natural Gas Price Henry Hub



Preliminary Long-term Natural Gas Price Forecast

for use in the Council's Seventh Plan



Results of NGAC Poll

	Range of Low Price Forecast			Range of Medium Price Forecast			Range of High Price Forecast		
	Minimum	Average	Max	Minimum	Average	Max	Minimum	Average	Max
2015	2.14	3.19	4.15	2.86	3.87	4.58	4.19	4.70	5.25
2020	2.06	3.46	4.17	3.03	4.45	5.10	4.17	5.53	7.28
2025	2.02	3.64	4.43	3.19	4.67	5.53	4.23	5.85	8.30
2030	2.03	3.66	4.89	3.14	4.66	5.84	4.07	6.06	8.76
2035	2.03	3.66	5.04	3.07	4.70	6.31	4.02	6.24	9.46

Among the respondents there is a wide range of expectations

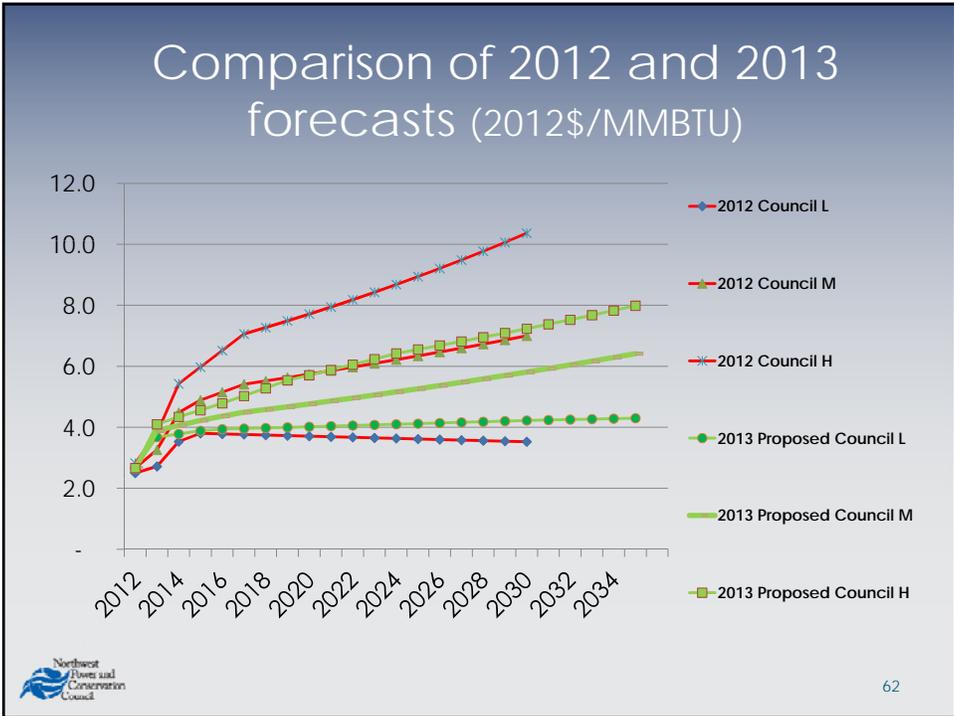


Proposed Henry Hub Price Forecasts	\$2012/MMBTU			Average values from NGAC Poll in 2012\$/MMBTU		
	Council L	Council M	Council H	Poll- LOW	Poll- Medium	Poll-High
2011	4.0	4.0	4.0			
2012	2.7	2.7	2.7			
2013	3.7	3.9	4.1			
2014	3.8	4.1	4.3			
2015	3.9	4.2	4.6	3.3	3.9	4.7
2020	4.0	4.8	5.7	3.7	4.6	5.6
2025	4.1	5.3	6.6	3.9	4.8	5.9
2030	4.2	5.8	7.2	3.9	4.8	6.2
2035	4.3	6.4	8.0	3.9	4.9	6.3
Average 2015-2035	4.1	5.3	6.4	3.7	4.6	5.8
Annual Growth rate						
2015-2020	0.7%	2.5%	4.6%	2.5%	3.3%	3.6%
2020-2025	0.5%	2.0%	2.8%	1.0%	1.1%	1.3%
2025-2030	0.5%	2.0%	2.0%	0.1%	0.0%	0.8%
2030-2035	0.4%	2.0%	2.0%	0.0%	0.3%	0.4%
2012-2035	2.1%	3.9%	4.9%	1.6%	2.6%	3.7%

Council's forecast of 2012 HH prices was 2.6 \$/MMBTU,
Actual HH price for 2012 was 2.7 \$/MMBTU



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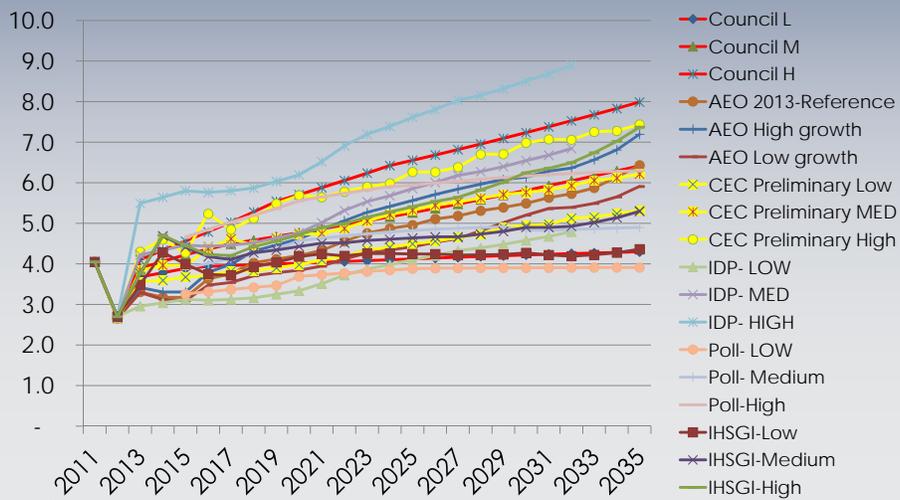


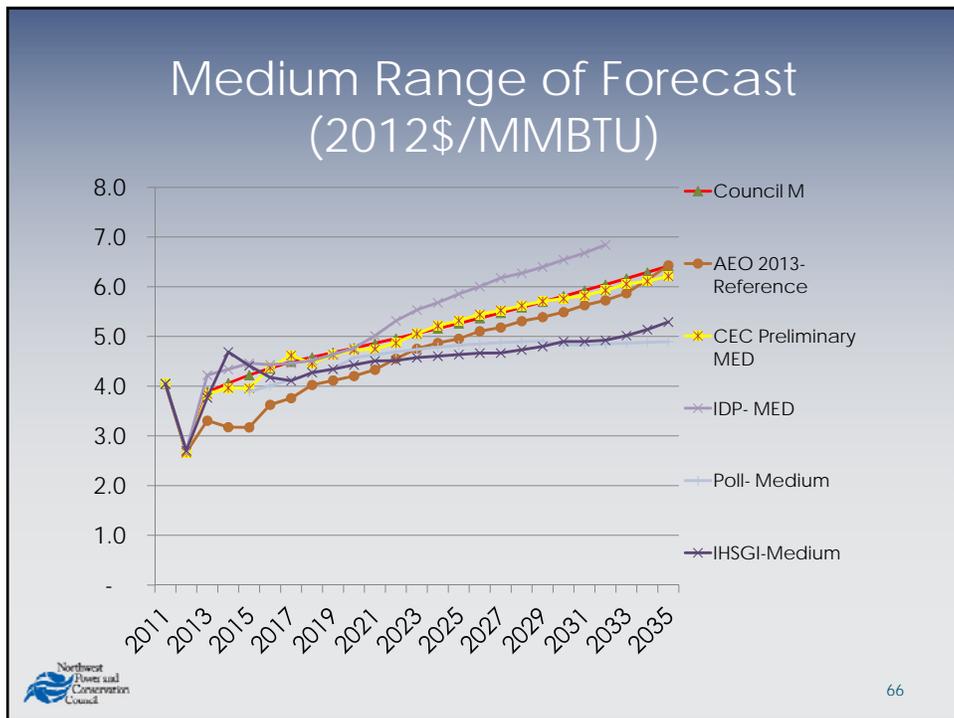
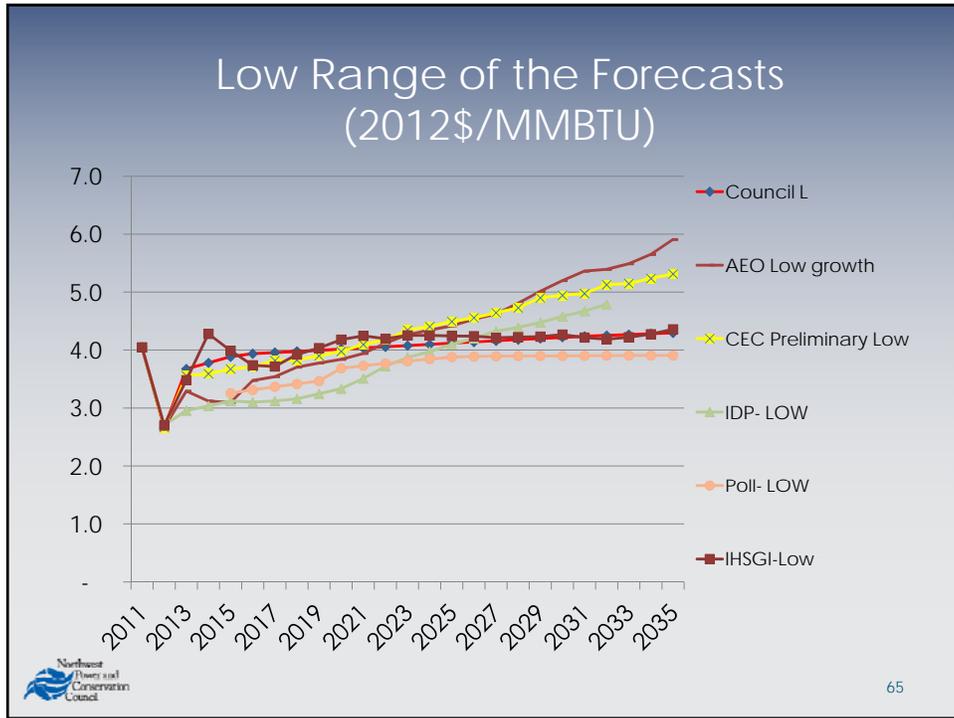
Comparison to other forecasts

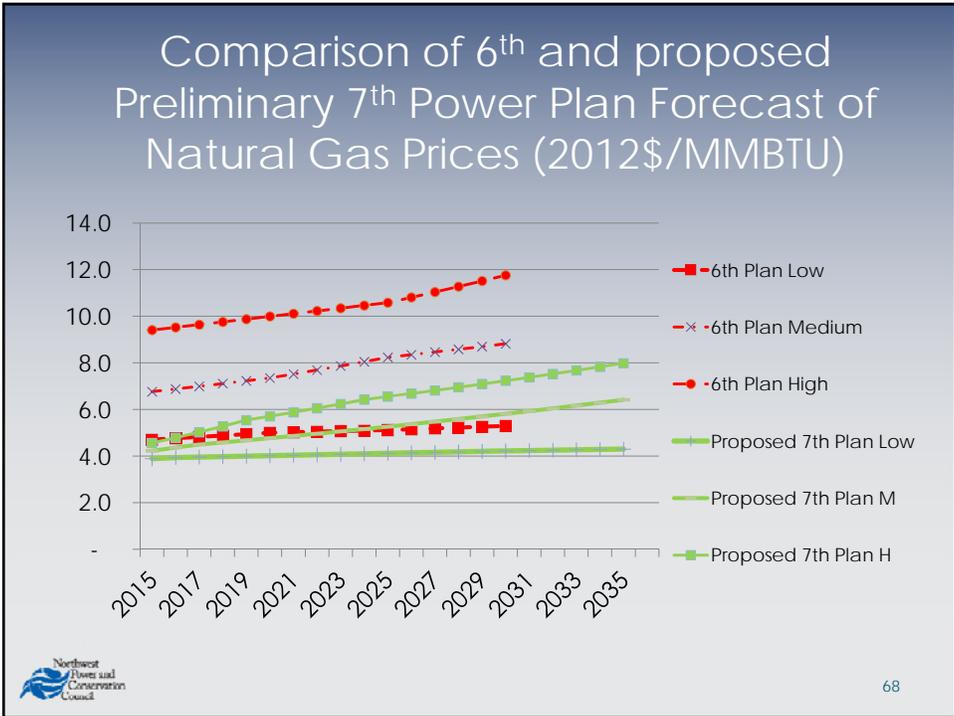
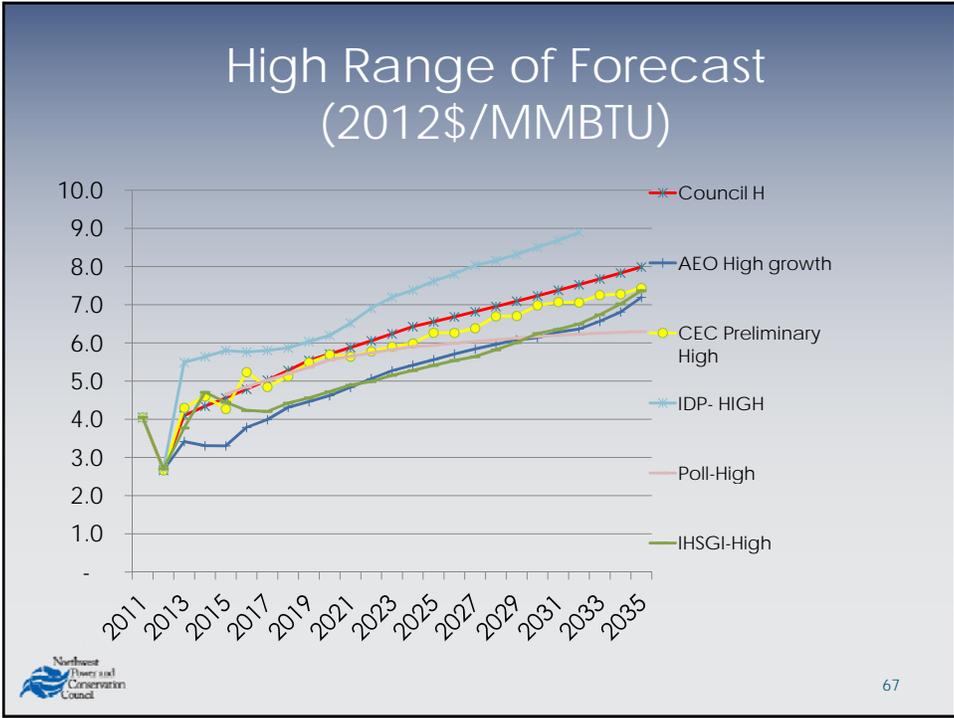
- AEO 2013 Reference case
- CEC 2013 (preliminary)
- IHS_Global Insight
- Natural Gas Week quarterly Analysts
- Idaho Power IRP
- Poll of NGAC members
- SNL (short-term 2013-2014)



Various Long-term forecasts (2012\$/MMBTU)







Would you recommend

- For 2013-2014 we use SNL market data?
- For 2015-2035 use a blend of strawman proposal and the poll results?
- Lower growth rate in long-term (post 2025 prices)?



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Fuel Prices Futures in Council's Portfolio Model

“Futures are how the Portfolio Model stress-tests resource strategies”

Dr. Michael Schilmoeller



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Sources of Uncertainty

- **Fifth Power Plan**
 - Load requirements
 - Gas price
 - Hydrogeneration
 - Electricity price
 - Forced outage rates
 - Aluminum price
 - Carbon allowance cost
 - Production tax credits
 - Renewable Energy Credit (Green tag value)
- **Sixth Power Plan**
 - Power plant construction costs
 - Technology availability
 - Conservation costs and performance



Different Kind of Risk Modeling

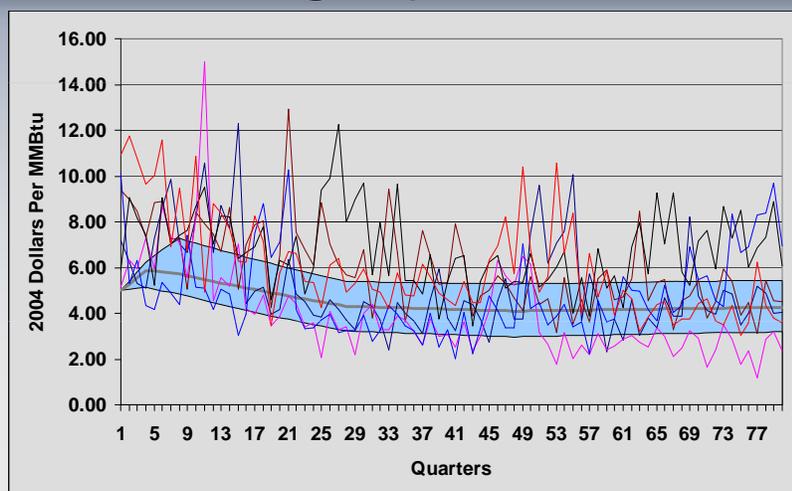
- Imperfect foresight and use of decision criteria for capacity additions
- Adaptive plans that respond to futures
 - Primarily options to construction power plants or to take other action
 - May include policies for particular resources
- “Scenario analysis on steroids”
 - 750 futures, strategic uncertainty
 - Frequency that corresponds to likelihood



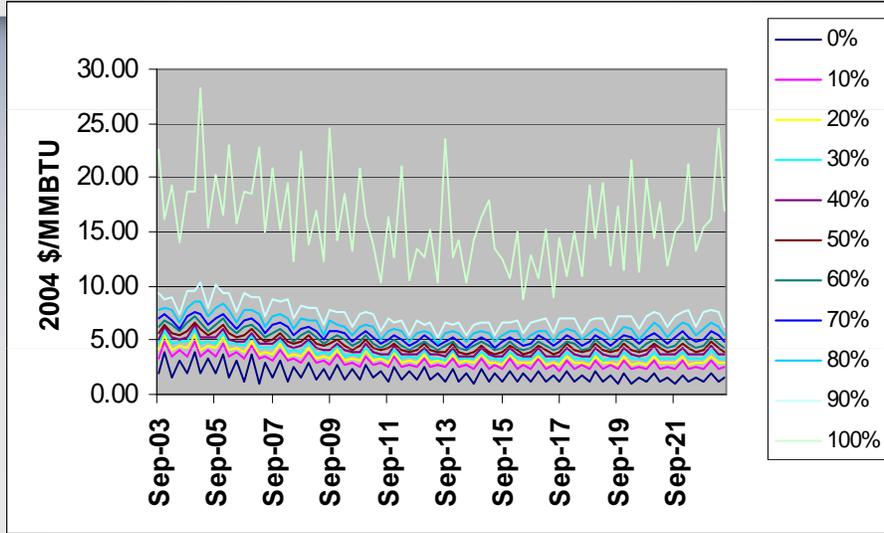
Observations

- **Stress-testing means**
 - Using extreme and unlikely futures
(Don't predict! Test!)
 - Looking at unusual relationships
(Remember the Mortgage Crisis!)
 - Thinking in terms of effect and categories of uncertainty, rather than detailed causes
(Remember Boardman and Centralia!)

Example risk treatment – natural gas prices

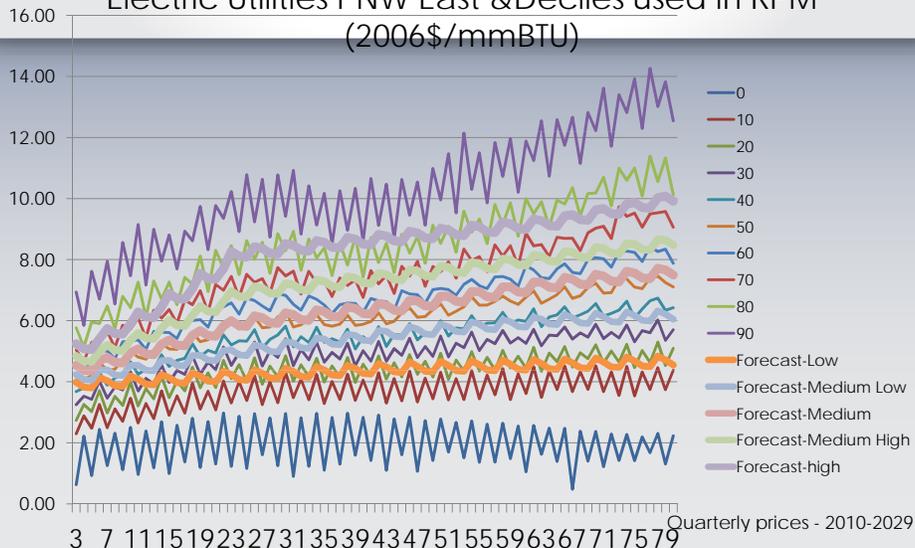


Natural Gas Prices



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Range of Forecast Natural Gas Price Delivered to Electric Utilities PNW East & Deciles used in RPM (2006\$/mmBTU)



For illustration only

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Next Steps

- Create the proposed fuel price forecasts for the Seventh Power Plan.
- Review and approval by Council- July
- Prepare report on updated price forecast - July
- Incorporate forecast fuel prices in:
 - Demand Forecast October 2013
 - Electricity price forecast November 2013
 - Council's Portfolio Model 2014



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Feedback on this year's format

- Does holding the meeting right after NWNGA annual conference work?
- Does the early start suit you.
- Any other comments???

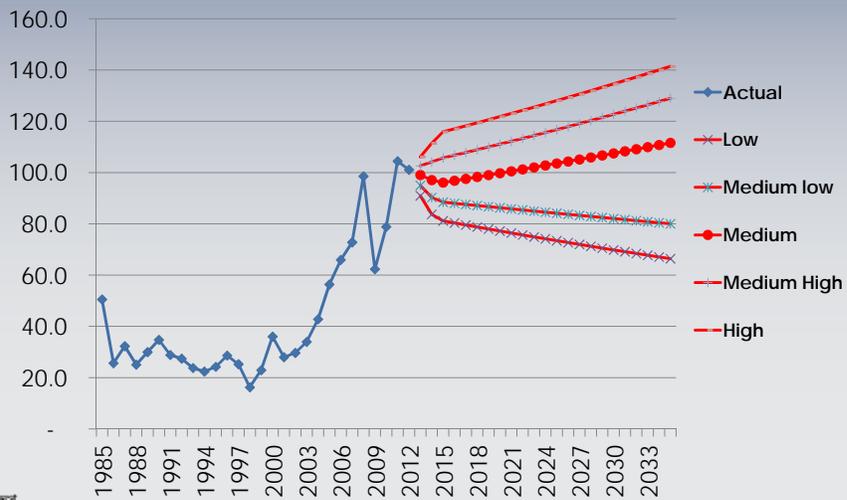


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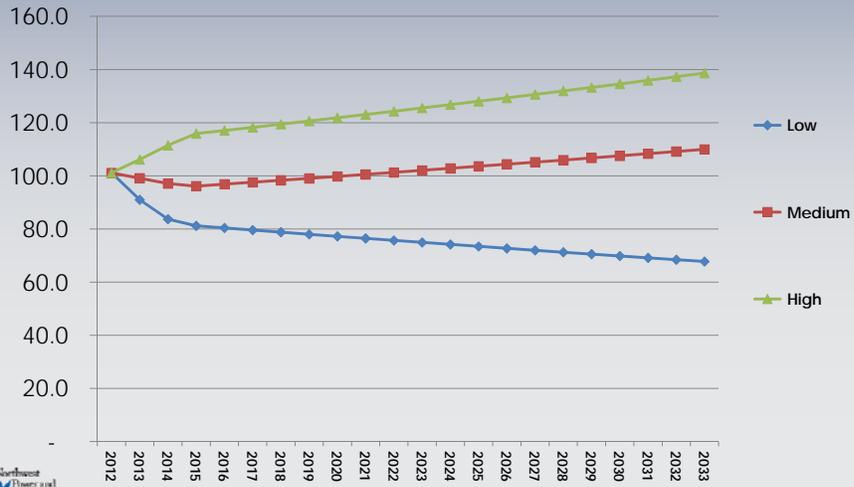
Thank you for your participation



Proposed Forecast of Refiners Acquisition Cost (2012\$/barrel) for use in Council's Seventh Power Plan

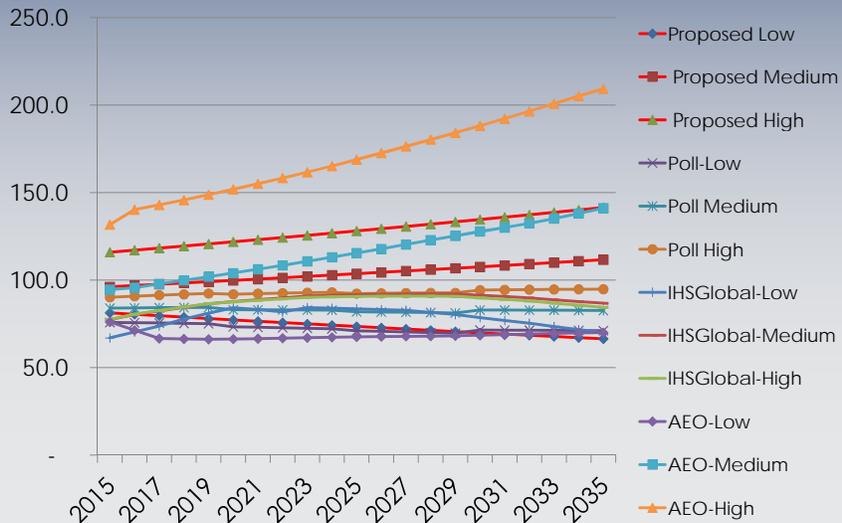


Proposed Forecast of Refiners Acquisition Cost (2012\$/barrel) for use in Council's Seventh Power Plan



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Comparison of RAQ Cost 2012\$/Barrel



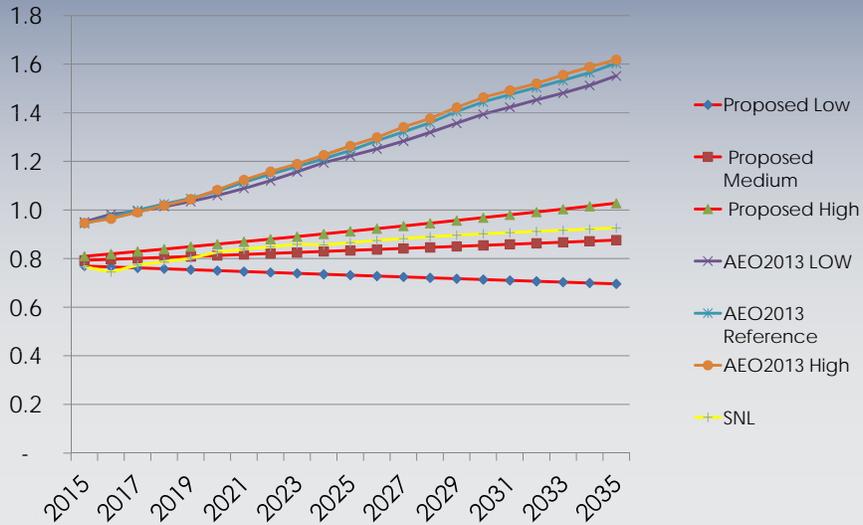
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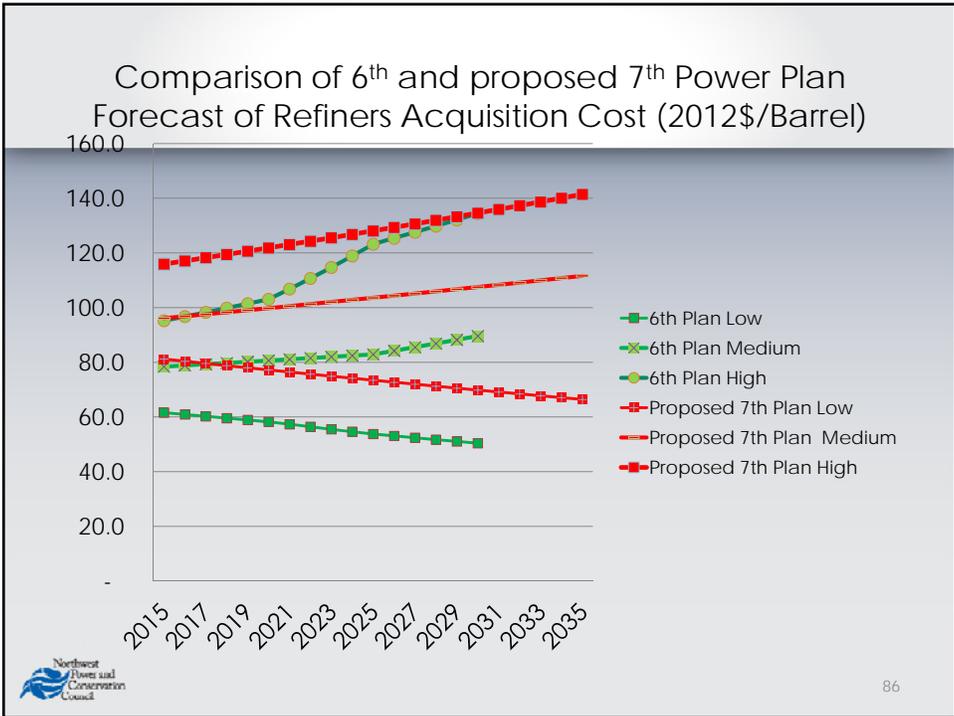
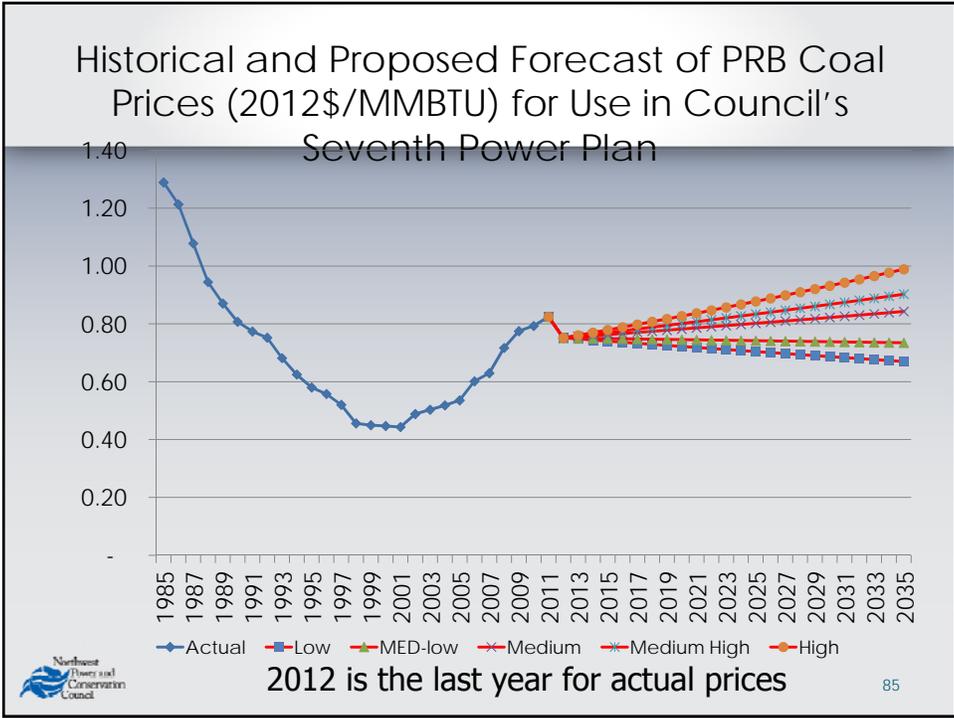
Proposed Oil Price Forecast for Council's Seventh Power Plan

Refiners Acquisition Cost \$2012 dollars per Barrel				Refiners Acquisition Cost \$dollars per Barrel			
	Low	Medium	High		Low	Medium	High
2015	81	96	116	2015	85	101	122
2020	77	100	122	2020	88	114	139
2025	73	104	128	2025	91	128	159
2030	70	108	135	2030	94	145	182
2035	66	112	141	2035	98	165	209



Comparison of PRB Coal Price Forecasts 2012\$/MMBTU





Proposed PRB price Forecast 2012\$/MMBTU

Year	Low	Medium	High
2015	0.77	0.79	0.81
2020	0.75	0.81	0.86
2025	0.73	0.83	0.91
2030	0.71	0.85	0.97
2035	0.70	0.88	1.03



Thank you for your participation

