Long-term Natural Gas Price Forecast

June 7th 2013

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
**Council’s Power Planning Process**

- Economic & Demographic Forecasts
- Fuel Price Forecasts
- Conservation Programs and Costs
- Generating Resources and Costs

**Demand Forecasting System**

- Residential
- Commercial
- Industrial
- Irrigation

**Total Electricity Use**

- Supply - Demand Balance (RPM Model)

**Resource Supply (Cost and Amount)**

**Electricity Price**

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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.
Relationship between Retail Natural Gas Prices and Henry Hub Prices

Henry Hub price forecast shown here is for example, Council’s natural gas price projections will be updated later this year.

Comparison of Forecast and Actual 2012 (2012$)

<table>
<thead>
<tr>
<th></th>
<th>Henry Hub Price Forecast 2012$/mmbtu</th>
<th>PRB Coal Prices 2012$/mmbtu</th>
<th>Refiners Acquisition Cost Forecast 2012$/ Barrel</th>
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<td>Low</td>
<td>$2.4</td>
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<td>$85</td>
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<td>Med-Low</td>
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<td>$90</td>
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<tr>
<td>Med-High</td>
<td>$2.7</td>
<td>$0.83</td>
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</tr>
<tr>
<td>High</td>
<td>$2.7</td>
<td>$0.84</td>
<td>$105</td>
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</tbody>
</table>

Except for coal, all fuel prices were within forecasted range.
2013 NWGA Outlook Overview

Natural Gas Advisory Committee
June 7, 2013
Portland, OR

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
Supply

BC Production Forecast

Source: Canada National Energy Board
Rockies Production Forecast

- Gas well drilling efficiency increases
  - 2011 average rig drilled twice the number of wells per year compared to 2006
  - Last 3 years average wells productivity increased 40%
  - Rig productivity up by almost 150% from 2006

Source: Kinder Morgan, US Energy Information Administration
Demand

Recent Gas Demand

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

* Estimated US December, Canada Q4
2012-2013 Forecast
2013 Outlook Demand Forecast

Forecast Comparison by End Use
I-5 Peak Day Demand-Resource Balance

- '08 Peak Day
- '13 Peak Day

- Projects
  - Southern Crossing Expansion
  - Palomar
  - Sunstone
  - Blue Bridge (N-MAX)
  - Ruby
  - Pacific Connector
  - Pacific Trail
  - Oregon LNG
  - Washington Expansion

- LNG Terminals
  - Kitimat LNG (export)
  - Bradwood Landing LNG
  - Oregon LNG
  - Jordan Cove LNG

- Storage Facilities
  - Mist
  - Jackson Prairie
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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

Robert V. Kennedy
Electricity Analysis Office
Electricity Supply Analysis Division
California Energy Commission
rkennedy@energy.ca.gov/916-654-5061
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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**Work Continuing with Cases (cont.)**

**Iterative Modeling Process**

- Rice University Production Costs
- Updated Economic/Demographic Assumptions
- North American Gas Model
- CA Transportation Demand Models
- WECC Electricity Production Cost Model
- CA Demand Models
### 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

### 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
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

North American Market Gas Trade Model: Developing a Cost Environment

- Staff must simulate the cost environment for analysis:
  - Graph shows indexed cost between 1960 and 2010
  - High cost environment ~ 1979 - 1984

Sources: Baker Institute.
California Energy Commission

Common Cases:
Supply Balance

Performance of Cases:
Lower 48

California Energy Commission

Common Cases:
Price Performance of Cases (Henry Hub)

Henry Hub Prices

- 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”
California Energy Commission

National Cases:
Price Performance of Cases (Differentials)

Topock - Henry Hub

- 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.

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

- Two main demands: End-use and Exports
- Demand satisfied by:
  - Canadian Imports
  - Lower 48 Production
  - LNG Imports

- 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
Common Scenarios:
Reconfiguration of Supply Portfolio (2025)

High Price/ Low Demand Case (+16.9%)
- Two main demands: End-use (-8.2%) and Exports (+61.0%)
- Demand satisfied by:
  - Canadian Imports (-2.3%)
  - Lower 48 Production (-0.8%)
  - LNG Imports (-100.0%)
- Competing sources of natural gas reconfiguring the supply portfolio

Canadian Imports: 13.0 Bcf/d

Lower 48
Production: 74.0 Bcf/d
Demand: 70.6 Bcf/d
Exports: 13.2 Bcf/d
LNG Imports: 0.0 Bcf/d

Low Price/ High Demand Case (-16.2%)
- Two main demands: End-use (+8.0%) and Exports (-36.5%)
- Demand satisfied by:
  - Canadian Imports (-0.8%)
  - Lower 48 Production (+5.0%)
  - LNG Imports (-58.3%)
- Competing sources of natural gas reconfiguring the supply portfolio

Canadian Imports: 13.2 Bcf/d

Lower 48
Production: 78.3 Bcf/d
Demand: 83.0 Bcf/d
Exports: 5.2 Bcf/d
LNG Imports: 0.1 Bcf/d

(%) Percent change from reference case.
Common Cases:
Supply Balance

Performance of Cases:
California

Common Cases:
Price Performance of Cases (Topock Hub)

• 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.
Common Cases: California Supply Portfolio (2025)

Reference Case

- California Demand: End-use
- Demand satisfied by:
  - Imports (Malin)
  - Rocky Mountain Supplies
  - Southwest Supplies
  - Local Production

California Imports (Malin): 2.67 Bcf/d
Southwest: 2.34 Bcf/d
Rocky Mountain: 1.22 Bcf/d

California Production: 0.21 Bcf/d
Demand: 6.33 Bcf/d

( ) Percent change from reference case

High Price/ Low Demand Case (+16.7%)

- California Demand: End-use (-8.2%)
- Demand satisfied by:
  - Imports (Malin) (-3.7%)
  - Rocky Mountain Supplies (-8.2%)
  - Southwest Supplies (-11.5%)
  - Local Production (-19.0%)
- Competing sources of natural gas reconfiguring the supply portfolio

California Imports (Malin): 2.57 Bcf/d
Southwest: 2.07 Bcf/d
Rocky Mountain: 1.12 Bcf/d

California Production: 0.17 Bcf/d
Demand: 5.81 Bcf/d

( ) Percent change from reference case
Common Cases:
California Supply Portfolio (2025)

- **Calif. Imports (Malin):** 2.79 Bcf/d
- **Rocky Mountain:** 1.32 Bcf/d
- **Southwest:** 2.73 Bcf/d

**Low Price/ High Demand Case (-13.2%)**

- California Demand: End-use (+10.6%)
- Demand satisfied by:
  - Imports (Malin) (+4.5%)
  - Rocky Mountain Supplies (+8.2%)
  - Southwest Supplies (+16.7%)
  - Local Production (+38.1%)
- Competing sources of natural gas reconfiguring the supply portfolio

**California**
- Production: 0.29 Bcf/d
- Demand: 7.00 Bcf/d

Summary:

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

Shale Production Uncertainty Cases: A Scenario Examination

Northwest Power and Conservation Council
Natural Gas Advisory Committee Meeting

June 07, 2013

Leon D. Brathwaite
Electricity Analysis Office
Electricity Supply Analysis Division
California Energy Commission

leon.brathwaite@energy.ca.gov/916-654-4771
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.

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.
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

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.
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%.

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%.
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.
Current Assumptions (subject to change)

Wholesale Price Forecast at Mid C
Straw Man Proposal for Preliminary Seventh Plan Forecast of Prices

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.
What a difference a year can make. June 11, 2012: prices in low $2 range.
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)
Preliminary Long-term Natural Gas Price Forecast for use in the Council’s Seventh Plan

Results of NGAC Poll

<table>
<thead>
<tr>
<th>Year</th>
<th>Range of Low Price Forecast</th>
<th>Range of Medium Price Forecast</th>
<th>Range of High Price Forecast</th>
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<tbody>
<tr>
<td></td>
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<td>Average</td>
<td>Max</td>
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<tr>
<td>2035</td>
<td>2.03</td>
<td>3.66</td>
<td>5.04</td>
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</table>

Among the respondents there is a wide range of expectations.
### Proposed Henry Hub Price Forecasts ($/MMBTU)

<table>
<thead>
<tr>
<th>Year</th>
<th>Council L</th>
<th>Council M</th>
<th>Council H</th>
<th>Poll-LOW</th>
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<td>Average 2015-2035</td>
<td>4.1</td>
<td>5.3</td>
<td>6.4</td>
<td>3.7</td>
<td>4.6</td>
<td>5.8</td>
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</tbody>
</table>

### 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

### Comparison of 2012 and 2013 forecasts (2012$/MMBTU)

![Comparison of 2012 and 2013 forecasts](chart.png)
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$/MMBTU)
Low Range of the Forecasts (2012$/MMBTU)

- Council L
- AEO Low growth
- CEC Preliminary Low
- IDP-LOW
- Poll-LOW
- IHSGI-Low

Medium Range of Forecast (2012$/MMBTU)

- Council M
- AEO 2013-Reference
- CEC Preliminary MED
- IDP-MED
- Poll-Medium
- IHSGI-Medium
High Range of Forecast (2012$/MMBTU)

Comparison of 6th and proposed Preliminary 7th Power Plan Forecast of Natural Gas Prices (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)?

Fuel Prices Futures in Council’s Portfolio Model

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

Dr. Michael Schilmoeller
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

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

For illustration only
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

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???
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

Comparison of RAQ Cost 2012$/Barrel
Proposed Oil Price Forecast for Council’s Seventh Power Plan

<table>
<thead>
<tr>
<th>Year</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Year</th>
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<td>2035</td>
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</table>

Comparison of PRB Coal Price Forecasts 2012$/MMBTU
Comparison of 6th and proposed 7th Power Plan Forecast of Refiners Acquisition Cost (2012$/Barrel)

Historical and Proposed Forecast of PRB Coal Prices (2012$/MMBTU) for Use in Council’s Seventh Power Plan

2012 is the last year for actual prices
### Proposed PRB price Forecast

2012$/MMBTU

<table>
<thead>
<tr>
<th>Year</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
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<tbody>
<tr>
<td>2015</td>
<td>0.77</td>
<td>0.79</td>
<td>0.81</td>
</tr>
<tr>
<td>2020</td>
<td>0.75</td>
<td>0.81</td>
<td>0.86</td>
</tr>
<tr>
<td>2025</td>
<td>0.73</td>
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</tr>
<tr>
<td>2030</td>
<td>0.71</td>
<td>0.85</td>
<td>0.97</td>
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<tr>
<td>2035</td>
<td>0.70</td>
<td>0.88</td>
<td>1.03</td>
</tr>
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</table>

Thank you for your participation