Northwest Power and Conservation Council
Natural Gas Advisory Committee
June 16, 2017

Steven Simmons, NPCC, began the meeting at 9:00am by calling for introductions and reviewing the agenda.

Summary of Comments from the Price Survey [Slide 3]
David Hawk, Energy Analysis and Answers, argued that no one defines stable [bullet 2] noting fifty cent fluctuations on $3 gas is not stable. Simmons agreed that it is relative.

Randy Friedman, NW Natural Gas, asked for the definition of "cycles, [bullet 4]. Simmons answered seasonal and business.

Natural Gas Price Forecast [Slide 6]
Fred Heutte, NW Energy Coalition, asked how the Henry Hub regional average gas price is calculated. Simmons explained the different modeling is used noting that AURORA uses east/west regional information. Heutte noted that AECO tends to swing and asked about smoothing. Simmons answered that AECO and some other hubs have individual, 10-year historic seasonal patterns, allowing him to break the actual annual price into months.

Massoud Jourabchi, NPCC, added that they also look at generator fuel cost data to best link to Henry Hub or AECO.

Terry Morlan, Independent, noted that the Regional Portfolio Model, (RPM) looks at both long-term uncertainty and short-term volatility.

Bill Dickens, Tacoma Power, asked if there is a way to evaluate the Seventh Power Plan gas price forecast relative to the NYMEX Strip. Simmons answered that some of that is done as a check, but pointed to long-term forecasting as the main goal.

Tomas Morrissey, PNUCC, asked if the forecast might be updated during the Plan's mid-term assessment. Jourabchi said it might be if there are significant discrepancies.

Northwest Pricing Hubs [Slide 7]
Hawk asked how electric utility's IRPs are used. Jourabchi answered that he looks at aggregated SEDS to get state-level forecasts. Hawk pointed to Idaho Power's recently completed IRP stressing the importance of referencing the natural gas price forecast for NW utilities. Simmons agreed, noting that he does look at available IRPs.

Friedman noted that price information in gas utilities IRPs can be old. Hawk countered that electric utilities are more current as they put out an IRP every two years. Friedman pointed to long approval times. Hawk noted process times east of the Cascades and speculated about those on the West

Natural Gas Prices & Modeling [Slide 8]
Heutte asked what annual plant capacity factor was used. Simmons answered that is for a single capacity factor of about 65%. Heutte noted large amounts of variation, stating that gas is often inversely proportional to hydro in the NW giving the capacity factor a bigger impact. Simmons agreed that the metric has some flaws but said the RPM looks at hundreds of hydro-year futures to capture volatility which would impact capacity factors.

Example--$/MWh Gas-Fired CCCT and Utility-Scale Solar [Slide 9]
Heutte pointed to the widening effect of different capacity factors calling it pivotal to the planning process. He suggested looking at a range of gas prices as opposed to a single line.

Hawk stated that he thinks of solar as having 33% capacity and asked about the remaining 63% that has to be made up. Simmons again noted the flaws of a levelized cost metric that looks at energy and not capacity. Simmons agreed that a CCCT could offer power at night. Hawk noted that this graph could easily be misinterpreted as it's not an apples-to-apples comparison.

Heutte stated that capacity is a new issue for the region and called looking at the lifecycle cost of energy a good tool with limitation. Friedman suggested adding a caveat disclaimer to the slide. Simmons agreed to add a note about the limitations of the levelized cost metric.

Dickens addressed the importance of a point gas forecast over a range, noting that utilities need a point for both budgeting and determining the shadow price of conservation. Heutte stated some models rely on a point but we should not fixate on that for planning purposes.

James Robbins, Kootenai Electric Co-op, stated that gas prices can vary significantly due to unseen forces like new demands and regulations and suggested caution when looking out more than five years.

Friedman pointed to probable flux on the demand side in 2020 due to coal-plant closures and LNG exports.

Lynne Dahlberg, Northwest Pipeline, wrote on chat, "Rick Perry, head of the DOE, is conducting a 60-day study of the U.S. electric grid, which attempts to determine if policies that favor wind and solar energy are accelerating the retirement of coal and nuclear plants that are critical to ensuring steady, reliable power supplies."

Sam Van Vactor, Economic Insight, Inc., asked when the DOE transmission study will be released, via chat. Simmons answered that he didn't know.

High Level Summary
Simmons moved to Consumption asking Robbins how he would increase the high/low range after five years. Robbins pointed to a variety of uncertainties including pipeline capacity and the long-term commitment needed to build more.

Jourabchi addressed a single-point forecast versus a range, noting that for Plan planning there is no middle, medium forecast to reflect need and uncertainty. Robbins agreed that you have to feed the model what it needs or change it, but stated that future prospects tend to be shaky and gas prices can move quickly. Robbins reflected that electricity and gas are notoriously hard to predict.

Hawk countered that long-term price fixes are available to credit-worthy industrial consumers.

Robbins pointed to significant advances in exploration technology that should be added to Supply & Production. Friedman stated that pipeline construction is missing as well. Simmons agreed to add infrastructure to the Summary.

Hawk noted that the new technology is very expensive but not as helpful for unconventional exploration plays. He noted that downturns in pricing and supply has created a shortage of experienced drilling crews.

Mike Hopkins, FortisBC, asked if transportation consumption, particularly on the marine side, is a factor. Simmons said his upcoming slide doesn't include transportation consumption as it looked low but asked for more insight. Friedman stated that nationally it will be tight but there may be bigger regional effects. Dan Kirschner, NW Gas Association, agreed, pointing to NW regional marine opportunities. Kirschner agreed that forecasting trends would be hard now but suggested that it might be easier by the Eighth Plan.

Ken Ross, FortisBC, mentioned a high-demand, natural-gas-for-transportation scenario that includes substantial marine fueling and international bunkering. He offered to graphically share some information. Simmons thanked him.

Jourabchi asked if Kirschner pulls transportation data for their outlook. Kirschner answered that they are gathering information now and will publish in the Fall. He looked forward to seeing the data and mused that there might be sidebar commentary on transportation prospects.

Morlan suggested a specific scenario to test effects. Jourabchi added that the Council is working on a transportation module for Energy2020 and is looking at the natural gas transportation sector. He suggested bringing it back in a year for feedback and comparison. Heutte mentioned the conundrum of transporting gas itself, through pipelines or on ships, which burns gas.

US Rockies [Slide 14]

Robbins asked if there is infrastructure pipeline to get gas out of Colorado. Dahlberg answered that the final 200-mile pipeline is proposed but there is pipeline available at Mancos. Hawk suggested that there isn't enough pipeline capacity for another billion cubic feet a day. Robbins pointed to the significant infrastructure construction needed to move a billion cubic feet a day, and the five-to-seven-year process needed for approval.

Heutte pointed to the large difference between resource (what is in the rocks) and reserve (how much can be extracted) and suggested using the term resource carefully. Hawk suggested using the Potential Gas Committee study for resource. Heutte noted that details of the report are behind a paywall.

Midland Basin Map [Slide 15]
Friedman stated that associated gas represents about 20% of the country's supply, so oil prices will affect supply too. Hawk argued that geographic discrepancies prevent a central statement.

Production [Slide 16]
Hopkins agreed that there is more supply but stated that lack of pipeline capacity will create volatility, referencing the 2014 Polar Vortex as example. Morlan asked if you need a price differential between an adequate market and supply region to increase pipeline capacity. Robbins agreed adding that projected times must be significantly over five years due to construction expense.

Dahlberg agreed that price differential is a driver but true demand pulls and supply pushes also come into play. Freidman stated that a price spread implies two, liquid points of comparison, but Portland, OR isn't one. He instead looks at alternatives: more underground storage or a LNG plant along with more pipeline capacity.

Heutte agreed with the points on [Slide 16] that call for steadier prices in the short run but referenced structural shifts in demand like exports back into Canada. He wondered when the Utica/Marcellus will flatten out and what will happen after 2020, calling it the biggest question.

Hawk noted that leases for unconventional drilling are being tied to production, which changes the scenario. He then stated that *Canadian BC* appears to have just scratched the surface of tremendous production potential with limited pipeline availability. Simmons reminded the group that presented data is from US sources only.

Annual Natural Gas Production: Historic & US EIA AEO 2017 [Slide 17]
Dahlberg stated that 20,000 Tcf seemed low. Heutte countered that this doesn't include Canadian imports. Morlan stated that this is possible production not integrated with demand.

Heutte pointed to LNG exports which will increase due to higher international prices but wondered for how long and by how much as pricing markets are changing. Morrissey stated that the global market has softened in the last five years. Heutte wondered about Russia.

Annual Natural Gas Consumption Historic & US EIA AEO 2017 [Slide 19]
Kirschner offered a slide that predicts a flat or declining Alberta, an increasing Rockies and dramatically increasing BC but they run a "No LNG" case due to no new markets and elections. He agreed that there is a lot of gas in the ground but it will not be produced without demand. Robbins added that demand is restricted by pipeline capacity.

Morlan asked about potential market effects of unconventional development outside the US and Canada. Heutte answered that the US and Canada have better rocks, an established industry and private land ownership on which to build the business.

Growth in Consumption is coming from the Power Sector [Slide 20]
Hawk asked Kirschner if natural gas consumption by utilities has bottomed out. Kirschner said it depends on the weather more today than before, noting that 2016/2015 saw the highest burn for generation but there is not much growth in the core market and declines in industrial demand.

Friedman noted that his IRPs show a small uptick in 2016, stressing that he doesn't look at industrial transport loads and if the Kalama methanol plant is built it will use 300 million *Bcf?* a day. There was back and forth talk about capacity and supply. Dahlberg noted that their acquired capacity will make the region tight. Simmons theorized that, with existing infrastructure alone, the potential methanol plant will add winter volatility.

Robbins stated if Kalama and Cove get into place, and coal-fired plants are replaced with gas-fired turbines, the capacity issue will grow. Heutte added that resource adequacy on the power side will also become an issue in this case. Robbins stated that on the GTN system capacity, firm contracts will flow but temporary could be interrupted. Heutte concluded that a large, new demand could have a significant effect on the Council's planning process.

Jourabchi asked about the plant' potentially high electrical consumption. Friedman stated that some electricity will be generated on site. He then noted that Jordan Cove will take five years of advance time, but other factors like Boardman, Centralia, wood fiber LNG and methanol could happen within three years.

Coal Retirements in the region [Slide 21]
Morrissey pointed out that regardless of oncoming builds, an existing, in-the-money combined cycle could have an effect too. Friedman agreed but wondered about their firm pipeline arrangements. Robbins pointed to major firm contracts on the GTN that expire between 2023 and 2028. Hawk jested that plans to decarbonize will tamp PG&E's and SoCalGas' need for capacity. Friedman pointed to increasing interest in renewable natural gas in these areas. Kirschner mentioned a webinar in renewable natural gas. Simmons offered to post some slides on the Council's website.

Heutte asked if the Council keeps plant-by-plant track of gas contracts. Simmons answered no. Robbins noted that pipelines put this information on their bulletin board but you wouldn't know it on a plant-by-plant basis. Morrissey stated that PNUCC has this data but was not sure how public it is. Robbins suggested that it could be reversed engineered.

Forecasts for electricity demand are dropping across the West [Slide 23]
Hawk suggested the Oregon will see growth due to expected cannabis growth.

California—Historic & Forecast Load Energy [Slide 24]
Friedman asked about more nuclear retirements. Simmons answered that it is something to watch.

Morlan stated that the dotted line is the actual electricity use forecast, asking what underlying trend accounts for its growth. Simmons pointed to the adoption of electric vehicles. Heutte noted that along with nuclear, a wave of old gas plants will be retired.

EXPORT [Slide 26]
Simmons discussed exporting LNG, making it the first time the US has been a net energy exporter since Dwight Eisenhower was president. Simmons told anecdotes of his grandmother growing up as Eisenhower's neighbor in rural Kansas.

US to become Net Exporter [Slide 27]
Heutte called the movement dramatic. Friedman countered that regionally we will be getting 2/3rds of our gas from Canada.

Cumulative LNG export capacity from US projects [Slide 29]
Friedman asked about potential effects due to instability around Qatar. Jourabchi noted that this has happened before and local representatives consider it a minor inconvenience. Morlan noted that this reminds him of Council forecasting in the days of paper shortages and cautioned that a large percentage of proposed projects don't come to fruition. Heutte countered that in the Gulf there is strong demand and firm deals in place. He concluded that what really matters for price is supply/demand balance and exports will join weather as an influence lever.

BREAK

Hawk asked Heutte about the future of exports to Mexico as they are now open to foreign investment. Heutte was not sure, but predicted the increased exports will continue for the next five years even as they develop their resource. Hawk agreed, but predicted that free world economics will make Mexico self-sufficient in 10 years.

NATURAL GAS PRICE SURVEY [Slide 33]
Morrissey asked about probabilities around the low and high forecast. Simmons answered that there are no quoted probabilities around this but there will be for RPM. Morlan asked if the low and high are similar to EIA's range. Simmons answered that the high is similar but the low is lower, pointing to the CEC's tight range. Friedman noticed that the low forecast in the Seventh Plan was correct, so far.

Survey Results—Medium Forecast Henry Hub [Slide 35]
Morrissey asked how big a delta between the survey result and the Plan is required to trigger an update for the midterm review. Simmons answered that there will be a new forecast regardless but unless there is a huge difference there won't be modeling re-runs.

Dickens asked if there are results for Sumas or if this is only Henry Hub. Simmons answered that it is only Henry Hub but he has Sumas if there is interest. Dickens expressed interest.

Survey Results—Low Forecast Henry Hub [Slide 36]
Hawk voiced a preference for information presented in two-year waves that tick up 3% over time as that better mirrors the drilling/production cycle. Simmons asked Hawk to send him an example. Hawk stated that he would try.

Robbins agreed, but again pointed to infrastructure needed to move increased supply to markets. Morlan moved to [Slide 43] to illustrate how this information is used in the planning process. He then asked Hawk if the four-year, peak-to-peak is the right supply/demand cycle or a reasonable assumption. Hawk answered that many producers talk about 18 months, but he felt that was short given obstacles of drilling on Federal land.

Heutte noted that prices went from $2 last year to about $3 today, but wondered what it will look like regionally after 2020. Friedman pointed to a delay in the Rover Pipeline to account for the price increase. Heutte asked if this effected the AECO and Sumas prices. Friedman shook his head no. Heutte said this brings up the national/international picture versus regional factors calling regional factors a separate story line. There were nods of agreement in the room.

Survey Results—High Forecast Henry Hub [Slide 37]
Friedman theorized that pipeline cycles may be more important than gas production cycles. Heutte asked how much variation is due to weather versus other issues like pipeline constraints. Friedman stated that Henry Hub didn't move a lot even during the Polar Vortex, but others did.

Dickens stated that this slide created the most angst at Tacoma causing them to file comments about a too-high high forecast. He suggested possible punishment for creating forecasts out of the reasonable realm. (There were laughs in the room.) Simmons took his point, noting the importance of the price survey and that it was a result of committee discussion. Friedman stated that prices at that time were close. Dickens countered that they were not $12 and he's never seen a forecast with double-digit highs.

Kirschner recalled the 2015 conversation about black swan events (fracking bans, methane-reduction legislation, etc.) that led to the high jaw. Hawk noted that the high forecast only has a 10% probability and the last 20 years brought three black swan events.

Heutte noted that he argued for a fairly high jaw as there could be a scenario from 2025 out where national production decreases. However, he doesn't predict $10 in 2025 or beyond because of fuel switching away from gas. Heutte warned that the future doesn't look like the past or the recent past.

Hopkins asked for the low, medium and high forecast on one slide, predicting that it will show a narrow range. Simmons showed survey results on forecast range [Slide 38] to show differences between low and high forecasts.

Morrissey noted that the RPM model creates a wider range of prices than is input due to jump logic and other factors [Slide 43]. He suggested the forecasting group look at how wide the range was given the concern about tail events and the fact that the model generates more. Jourabchi added that the RPM tries to capture quarterly weather and economic events and includes low cases too. Morrissey stated that if the goal is capture a 5% chance of a high price the input is not the best place for that.

Heutte stated that if you average over time it shows a fairly flat trend and asked for a high gas scenario to check the impact. Morlan noted that the Council picks out high cases to further examine the implications.

Robbins stated that, as a BPA customer, he would like to see high natural gas prices as it makes his rates better, however he doesn't see it happening.

Hawk stated that the group hasn't discussed the ability of the industry to react to higher prices, noting a consolidation of EMP and shale companies. Robbins asked if that is typical of his proposed wave theory and guaranteed that if the price went to $7-$8, EMP companies would "sprout out of the ground."

Friedman theorized that it is unlikely to be on the high or low case for 20 years and more likely to cycle back and forth. He asked how the Council's model could represent that. Jourabchi pointed to jump logic in the RPM and sensitivity runs.

Morlan asked if the model still has separate draws from the long-, medium- and short-term cases. Jourabchi answered that the model is the same, adding that he checked the Seventh Plan, high-case projections and they were in line with NGAC projections, implying Tacoma would have to share in the punishment. There were laughs in the room.

Survey Results—Forecast Low, Medium, High [Slide 39]
Friedman asked if the low case represents flat real dollars. Simmons answered yes. Kirschner suggested adding in the EIA base case as this is a bit different. Morlan and Simmons answered that the EIA base case would be similar to the Seventh Plan medium case, represented by the red line.

Jourabchi called attention to the need to re-contact survey respondents to check if data was sent as constant dollars or nominal dollars.

Kirschner again stressed that this is a bit of a departure, checking the comfort level of the group and the Council as the forecast was a blend in the past. Jourabchi called this update lighter, noting that there are more comparisons in the full forecast.

Robbins asked if the conclusion is stable prices until 2025 followed by a rise. Simmons answered that medium prices stay fairly flat with a greater chance of the range rising in 2024. Hawk disagreed, stating he sees more volatility particularly at Henry Hub due to LNG.

Hawk then asked about potential black swan events. Simmons moved to **Natural Gas Price Volatility [Slide 41].** Hawk suggested adding a $40 CO2 adder to electric prices.

Heutte noted that [Slide 39] is in nominal dollars but it will be well below $4 in 2030-35 real dollars while EIA is $5. Jourabchi reiterated the need to revisit the chart after a follow-up.

Hopkins asked to see all the ranges on one chart once reconfirmed, predicting it will be narrower and lower than the Plan. Friedman agreed. Morlan noted that forecasters are historically influenced by the current market.

Natural Gas Price Volatility [Slide 41]

Friedman suggested adding tax code changes that discourage imports and encourage exports. Hawk expressed amazement. Friedman countered that, while the likelihood is small, people who buy 2/3rd of their gas from Canada will effectively see higher prices. Morlan suggested that this may cause energy-intensive industries to repatriate.

Morrissey suggested adding regulatory changes. Hawk suggested including seismic disruption.

Dahlberg wondered about the Western imbalance market and how companies and entities joining it could potentially change demand. Simmons suggested that more efficient use of electricity may drive gas demand down. Dahlberg agreed that that is her initial conclusion.

Hopkins stated that the EIM may be the mechanism, but the influx of renewables will increase volatility. Dahlberg agreed but stated that who gets dispatched could change the picture locally.

Friedman asked about renewable energy credit assumptions. Simmons noted that the RPS is not tied to tax credits. Friedman pointed to existing wind credits and wondered about them continuing. Simmons stated that generation modeling takes into account what's on the books at the time with an expectation of it tailing off. Morrissey remembered that most renewable development was driving by RPS.

Dickens recalled that Oregon had not yet changed their RPS at that time and Washington tends to copycat. Friedman asked if Washington's Clean Air Rule has any effect. Yes, it does, answered Dickens.

Heutte recalled that Washington's RPS proceeded Oregon's and there are many discussions on where it goes next. He then stressed the importance of separating short-term effects (East Coast weather, inventory amounts and congestion on pipelines) and long-term drivers (overall supply/demand.)

Morlan disagreed, saying they are mixed to measure the relative risk associated with different resources. Heutte stated that making capital investment decisions is about longer-term drivers. Simmons presented **Winter Daily Prices at Sumas $/mmbtu [Slide 42]** to show the Polar Vortex's past effect. Robbins agreed, stating that you have to look at the Northwest in relationship to the objectives of the Council as they are looking for alternatives to electric supply.

Heutte stated that the Northwest is relatively isolated from the national market and BC Alberta wants to come here. He asked if that will change as production peaks in the East over time.

Robbins asked production people if there is an underestimation of Marcellus as the experts have been wrong before.

Kirschner suggested another potential black swan event: extracted methane hydrates. He noted Japan and Korea's high motivation to be energy independent, suggesting success could crater a LNG export market.

Robbins pointed to a landfill generator that produces 650 BTU gas, which is not enough to use in turbines. Hawk pointed to pressure variations that also cause issues. Teresa Hagins, Northwest Pipeline LLC, wondered if there could be a gas-side effect similar to the behind-the-meter waste found on the solar side where it all can't be used at the time it's produced.

Kirschner noted higher value for RINs the transportation market, pointing to Federal RINs upwards of $70. There was back and forth discussion on how to accomplish this. Kirschner stated that these are potential future events that could have an effect on the fuel price forecast.

Morrissey asked how volatility is captured in the RPM, wondering if jaws of volatility start narrow and widen as they go out to 2030. Simmons wasn't sure if they changed over time but agreed that the jaws open only so much over the years.

Simmons reminded the group that they do look at historic Sumas, AECO and Opal volatility which reflects Western weather.

Heutte noted that Emerald PUD has a 3MW landfill gas plant that works, saying there are more small opportunities to be found. He then stated that commercial-scale methane hydrates would be game changer for the Northwest as there is a large resource off of the Oregon coast.

Simmons wrapped up, stating that he would follow up on the real versus nominal dollars issue for the price survey and update the website. Hawk thanked Simmons for the opportunity to be on the NGAC and hear and share information.

Simmons thanked him, ending the meeting at 12:45.

Attendees

James Robbins	Kootenai Electric Co-op
Bill Dickens	Tacoma Power
Terry Morlan	Independent
Randy Friedman	NW Natural Gas
Teresa Hagins	Northwest Pipeline LLC
Dan Kirschner	NW Gas Association
Fred Heutte	NW Energy Coalition
Tomas Morrissey	PNUCC
Michael Cox	BPA
Connor Reiten	NW Gas Association
Steve Simmons	NPCC
Massoud Jourabchi	NPCC

Attendees via Webinar

Daniel Avery	Oregon Dept of Energy
David Hawk	Energy Analysis and Answers
Greg Nothstein	WA Dept of Commerce
Mike Hopkins	FortisBC
Lynn Dahlberg	Williams Northwest Pipeline LLC
Michael Deen	Public Power Council
Jassi Randhawa	FortisBC
Ken Ross	FortisBC
Sam Van Vactor	Economic Insight, Inc.
Tom Pardee	Avista
Chris Weber	Tacoma Power