Docket No. RP16-___-000
Exhibit No. ANR-035

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

ANR Pipeline Company) Docket No. RP16 -___-000

Summary of Prepared Direct Testimony of Alexander J. Kirk

Mr. Kirk, who is employed by Brown, Williams, Moorhead & Quinn, Inc. as a Vice President, presents prepared direct testimony on behalf of ANR Pipeline Company ("ANR"), to (1) provide an assessment of the potential gas supply available to ANR; and (2) present factors affecting the demand for ANR's transportation services. Mr. Kirk's analysis is used in support of ANR witness Crowley's testimony regarding depreciation and the economic life of ANR.

Mr. Kirk presents estimates of the non-speculative gas resources available within the Eastern U.S. Region (includes U.S. Energy Information Administration ("EIA") Regions East, Midcontinent, Southwest, and Gulf Coast). Next, Mr. Kirk examines 30 scenarios of production by the U.S. EIA and compares the amount of production under these scenarios with the estimates of non-speculative resources within the Eastern U.S. Region. Mr. Kirk's comparison shows that non-speculative gas supplies within the Eastern U.S. Region should be available for transport on ANR's system for a 35-year period if sufficient demand exists.

Even if sufficient supplies exist, factors affecting demand may limit the amount of *available* supplies that could be expected to be produced and to flow on ANR. Mr. Kirk also provides evidence regarding the demand for natural gas in the long-run. Mr. Kirk testifies that consideration of demand is important because even if supplies are available, factors of demand may limit the amount of available supplies that could be expected to flow on ANR's system. Mr. Kirk identifies three sources of uncertainty with regard to natural gas demand: (1) technological

development in alternative energies; (2) potential gains in energy efficiency; and, (3) energy and environmental legislation/regulation. While there is less uncertainty of demand for natural gas in the short-run, Mr. Kirk explains that demand could change considerably in the long-run due to these three sources of uncertainty.

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BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

ANR Pipeline Company	)	Docket No. RP16 -___-000

PREPARED DIRECT TESTIMONY OF ALEXANDER J. KIRK ON BEHALF OF ANR PIPELINE COMPANY

January 29, 2016

Glossary of Terms

AEO	Annual Energy Outlook
ANR	ANR Pipeline Company
BWMQ	Brown, Williams, Moorhead & Quinn, Inc.
Commission	Federal Energy Regulatory Commission
CPP	Clean Power Plan
DOE	Department of Energy
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
GWh	Gigawatt-hours
NREL	National Renewable Energy Laboratory
PGC	Potential Gas Committee
PGC Report	April 2015 PGC report entitled "Potential Supply of Natural Gas in the United States"
PPA	Power purchase agreement
Tcf	Trillion cubic feet

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ANR Pipeline Company) Docket No. RP16 -___-000

Prepared Direct Testimony of Alexander J. Kirk

I. WITNESS INTRODUCTION AND PURPOSE OF PREPARED DIRECT TESTIMONY

Q. Please state your name, occupation and business address.

A. My name is Alexander J. Kirk and my business address is 1155 15th Street, N.W., Suite 1004, Washington, D.C. 20005. I am a Vice President of Brown, Williams, Moorhead & Quinn, Inc. ("BWMQ"), an energy consulting firm located in Washington, D.C.

Q. What is the nature of the work performed by your firm?

A. We offer technical, economic, and policy assistance to the various segments of the natural gas pipeline industry, oil pipeline industry, and electric utility industry on business and regulatory matters.

Q. On whose behalf are you presenting Prepared Direct Testimony in this proceeding?

A. I am presenting Prepared Direct Testimony at the request of ANR Pipeline Company ("ANR").

Q. Are you sponsoring any exhibits with your Prepared Direct Testimony?

A. Yes. I am sponsoring the following exhibits:

Exhibit No. ANR-036	Curriculum Vitae
Exhibit No. ANR-037	Non-Speculative Resources Tabulation
Exhibit No. ANR-038	Production Projections by the EIA
Exhibit No. ANR-039	Total Energy-Related CO_2 Emissions Projections by the EIA

Exhibit No. ANR-040	DOE Strategic Plan and White House Press Briefing
Exhibit No. ANR-041	DOE Methane Factsheet and EPA Methane Measures
Exhibit No. ANR-042	DOE Photovoltaic System Pricing Trends
Exhibit No. ANR-043	DOE 2014 Wind Technologies Market Report
Exhibit No. ANR-044	National Renewable Energy Laboratory Scenario Results

Q. Please describe your educational background and experience.

A. I earned a Bachelor of Science degree with majors in Mathematics and Economics from Linfield College in 2005, and a Masters in Economics from the University of Washington in 2008, with specializations in econometrics and natural resource and environmental economics. From September 2008 to May 2010, I was an instructor for Principles of Microeconomics and Natural Resource Economics courses at the University of Washington. I have been employed by BWMQ since June 2007, where I have assisted clients with natural gas pipeline rate cases, storage and pipeline market-based rate applications, business risk, rate design, and both traditional and levelized cost-of-service modeling. My complete curriculum vitae is attached as Exhibit No. ANR-036.

Q. Have you previously testified before the Federal Energy Regulatory Commission ("FERC" or "Commission")?

A. Yes, a list of the cases in which I have provided testimony and/or testified during my career is also included in my curriculum vitae attached as Exhibit No. ANR-036.

Q. What is the purpose of your Prepared Direct Testimony in this proceeding?

A. The economic life of a pipeline is influenced by the supply of natural gas and the demand for its transportation services. Either supply or demand may therefore be the primary constraining factor with regards to a pipeline's economic life. In Section II, I review the gas supplies that are available to ANR to determine whether sufficient gas supplies are

likely to be available over a 35-year horizon under numerous scenarios. In Section III, I discuss some of the factors affecting demand for ANR's transportation services to determine the degree to which demand is uncertain and may be the constraining factor with regard to economic life. My analysis is used in support of ANR witness Crowley's Prepared Direct Testimony regarding depreciation and the economic life of ANR.

II. GAS SUPPLIES AVAILABLE TO ANR

Q. Why is it important to examine gas supply when determining a pipeline's economic life?

A. A pipeline's economic life can be significantly impacted by the availability of natural gas supplies. The purpose of this portion of my analysis is to confirm whether sufficient gas supplies are available to flow on ANR assuming there is sufficient demand (discussed in Section III) for such transportation. This analysis of gas supply supports ANR witness Crowley's determination of the remaining life of ANR's system and his depreciation analysis.

Q. How did you select the regions to analyze as the basis of your gas supply study?

A. Historically, the Commission has required pipelines to file gas supply information supporting the economic life of their pipeline systems by analyzing the potential recoverable natural gas reserves in a pipeline's gas supply area. See, e.g., *Trunkline Gas Co.*, 90 FERC ¶ 61,017 at 61,057 (2000). ANR's primary sources of supply historically have been the U.S. Midcontinent and the Gulf Coast, with markets historically located in the Great Lakes region. As production in the U.S. Northeast has increased, natural gas from the Marcellus Shale and Utica Shale also have become sources of supply. Based on ANR's geographic footprint and after reviewing the regions used by the Energy Information Administration ("EIA") and Potential Gas Committee ("PGC") (described more

fully later), I determined that ANR's supply regions should include what the EIA defines as the East, Midcontinent, Southwest, and Gulf Coast Regions. See the EIA region map below.

Source: U.S. Energy Information Administration, Office of Energy Analysis.

These EIA regions very closely overlap with the PGC's North Central, Mid-Continent, Atlantic, and Gulf Coast Regions. I use the term "Eastern U.S. Region" to describe this supply region that I used for ANR's supply analysis, which is the summation of these EIA and PGC regions.

Q. If natural gas markets are fully integrated and natural gas from supply basins across North America compete to serve end-use markets, would it be appropriate to use the total gas supplies from North America, or some subset thereof in addition to Eastern U.S. Region supplies, in determining the resource base available to ANR?

A. No. There are four primary reasons why such an analysis would be improper and why my gas supply analysis focuses on the future availability of Eastern U.S. Region supplies. First, Commission precedent in depreciation practice provides that gas supply studies should be focused on the areas of supply that are in reasonable proximity and connectivity to the pipeline system being analyzed. For example, the Commission in *Trunkline Gas Co.*, 90 FERC ¶ 61,017 at 61,057 (2000), adopted a gas supply analysis

that included supplies located in areas near the footprint of Trunkline, including Railroad Commission of Texas District 2, 3, and 4, onshore South Louisiana, and Federal Offshore Louisiana. In *Williston Basin Interstate Pipeline Company*, 107 FERC ¶ 61,164 (2004), the Commission adopted a gas supply analysis that included the Western Canadian Sedimentary Basin and the Rocky Mountains, areas that could reasonably be expected to provide supplies to Williston Basin in the future, and excluded more distant supplies. Second, although it is likely that gas supplies from other areas will impact ANR, much of this impact will be from displacement or exchanges. This is particularly the case in the Northeast where growing production initially displaced gas supplies from the Rocky Mountains, which later led to the reversal of a portion of the Rockies Express Pipeline. Third, my analysis of the Eastern U.S. Region is, in part, based on Commission precedent that holds that gas supply forecasts in excess of 35 years are speculative. I have reservations regarding forecasts of both gas supply and demand beyond a 35-year horizon, which I will explain in detail later. Fourth, I conclude that gas supplies from the Eastern U.S. Region will be available to the ANR system for 35 years. As such, consideration of gas supplies from other areas would not change my conclusion that gas supplies will be available to the ANR system for the entirety of the maximum 35-year period the Commission, as discussed below, has found is appropriate to include in a depreciation analysis.

Q. What methodology did you use to analyze the gas supply availability in the Eastern U.S. Region?

A. I analyzed the total amount of non-speculative resources that I describe in each region in Section II.A and II.B. Next, I examined the EIA's Annual Energy Outlook ("AEO") 2014 and 2015 projections to show what I describe as plausible projections of natural gas

production. I examined both years of EIA's projections because the 2015 edition is more limited, since in 2015 the EIA began using a two-year cycle, providing a shorter edition and longer edition in alternating years. I then confirmed that sufficient non-speculative gas resources will be available over a 35-year horizon to satisfy natural gas production projections under the EIA's various scenarios. While I discuss why these scenarios are likely to overestimate production (and, therefore, consumption) later in my testimony, utilizing these scenarios allows me to determine whether or not supply is likely to constrain ANR's economic life over the next 35 years.

Q. Why did you examine a 35-year horizon for gas supply?

A. I examined a 35-year horizon based on Commission precedent that provides that projections beyond 35 years are speculative. Specifically, in *Portland Natural Gas Transmission Sys.*, 134 FERC ¶ 61,129 at P 127 (2011), the Commission noted:

> The ALJ rejected [Portland Shippers Group's] recommended end-life of 40 years for Portland's system, finding it extended beyond the Commission's standard of 35 years, and is inconsistent with Commission precedent indicating that reserve estimates projected beyond 35 years are speculative.

The Commission affirmed the Administrative Law Judge's ("ALJ") rejection of the Portland Shippers Group's and Staff's recommended life beyond 35 years. I discuss factors regarding demand in Section IV that cause forecasts of demand beyond 35 years to be highly uncertain as well.

A. Description of Data Used for the Eastern U.S. Region

Q. What states and areas comprise the regions you analyzed?

A. The Eastern U.S. Region encompasses many states and basins. The states, which are shown in the EIA Region Map earlier in Section II, are listed in Exhibit No. ANR-037.

These EIA regions overlap closely with the PGC's North Central, Mid-Continent, Atlantic, and Gulf Coast regions. The specific PGC basins that are located in the Eastern U.S. Region are also provided in Exhibit No. ANR-037.

Q. What is the source of the data you used to analyze gas supply?

A. I examined proven reserves data from the EIA's Form EIA-23, and estimates of probable and possible resources from the PGC's April 2015 report entitled "Potential Supply of Natural Gas in the United States" ("PGC Report"). I provide further detail with respect to these data sources in Section III.B. I also analyzed projections from the EIA's Annual Energy Outlook 2014 and 2015. Complete details regarding all EIA sources are available on the agency's web site, www.eia.gov.

Q. What is the PGC?

A. The PGC is an independent organization that works closely with the Potential Gas Agency at the Colorado School of Mines, and consists of volunteer members from all segments of the oil and gas industry, government agencies, and academic institutions. The PGC offers biennial estimates of the potential gas supply of the United States which can be used to estimate the long-term gas supply. As discussed later below, the Commission has previously relied upon PGC estimates to assess gas supply.

B. Discussion of Remaining Non-Speculative Resources

Q. What is the estimated quantity of remaining natural gas resources in the Eastern U.S. Region?

A. I calculated an estimate of what I term remaining "non-speculative resources" by summing dry proven reserves, probable resources, and possible resources, using the latest data available. The EIA's estimate of remaining proven reserves for the Eastern U.S. Region is 242.9 Tcf. I utilized the independent estimate of the PGC to determine the quanti-

ty of additional resources to include. The PGC's latest estimate of probable and possible resources for the Eastern U.S. Region is 1,291.9 Tcf. Total non-speculative resources therefore equals 1,534.8 Tcf (242.9 Tcf of proven reserves plus 1,291.9 Tcf of probable and possible resources). The tabulation of resources by state (proven reserves) and basin (probable and possible resources) is shown in Exhibit No. ANR-037.

Q. Would you please describe the PGC estimates?

A. The estimates of the PGC represent potential gas resources that, in the judgment of its members, can be recovered by future drilling under: (a) adequate economic incentives in terms of price and cost, and (b) current foreseeable technology. The PGC projects resources based on knowledge of areas of proven reserves. The PGC's estimates included in this study represent "Most Likely" values derived from statistically aggregated mean values.

Q. You said the PGC's "Most Likely" estimates are statistically aggregated mean values. What does this mean?

A. The "Most Likely" estimates, as described by the PGC, "represent the best judgment of individual Committee members and are considered the most credible assessments for purposes of analysis, planning and exploration." See PGC Report at 2. The Commission had explicitly relied upon PGC estimates in *Trunkline Gas Co.*, 90 FERC ¶ 61,017 at 61,057 (2000).

Q. What is the difference between proven reserves, probable resources, and possible resources?

A. Proven reserves are defined by the EIA as "the estimated quantities which analysis of geological and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under existing economic and operating conditions."

See Form EIA-23, *Annual Survey of Domestic Oil and Gas Reserves*. Probable, possible, and speculative resources are estimated by the PGC. As defined by the PGC:

> Probable resources are associated with known fields and are the most assured of potential supplies. Relatively large amounts of geologic and engineering information are available to aid in the estimation of resources existing in this category. Probable resources bridge the boundary between discovered and undiscovered resources. The discovered portion includes the supply from future extensions of *existing pools* in known productive reservoirs … Although the pools containing this gas have been discovered, their extent has not been completely delineated by development drilling. Therefore, the existence of quantity of gas in the undrilled area of the pool are as yet *unconfirmed*. The undiscovered part is expected to come from future new pool discoveries within existing fields either in reservoirs productive in the field or in shallower or deeper formations known to be productive elsewhere within the same geologic province or subprovince. (*See* PGC Report, Page 97. Emphasis in original. Endnotes omitted)

By contrast,

> Possible resources are a less assured supply because they are postulated to exist outside known fields, but they are associated with a productive formation in a productive province. Their occurrence is indicated by a projection of plays or trends of a producing formation into a less well explored area of the same geologic province or subprovince. The resources are expected to arise from *new field* discoveries, postulated to occur within these trends or plays under both similar and different geologic conditions—that is, the types of traps and/or structural settings may be either the same or different in some aspect. (*See* PGC Report, Page 97. Emphasis in original. Endnotes omitted)

The PGC defines speculative resources as:

> Speculative resources, the most nebulous category, are expected to be found in formations or geologic provinces that have not yet proven productive. Geologic analogs are developed in order to ensure reasonable evaluation of these unknown quantities. The resources are anticipated from *new pool* or *new field* discoveries within a productive province or sub-province and from *new field* discoveries within a *province not previously productive*. (*See* PGC Report, Page 97. Emphasis in original. Endnotes omitted)

Summing proven reserves, probable resources, and possible resources, I calculated total remaining non-speculative resources. I excluded speculative resources from my analysis

due to the "nebulous" nature of their existence. The Commission has stated that it is appropriate to rely on "the PGC's most likely estimates for probable and possible resources in [a pipeline's] gas supply areas." *See Trunkline Gas Co.*, 90 FERC ¶ 61,017 at 61,057 (2000). Speculative resources should only be included in a gas supply analysis if and when the resources are reclassified as proven, probable, or possible.

C. Production Projections

Q. Why did you examine production projections?

A. The estimates for non-speculative resources I discussed in Section II.B are measurements of the stock of resources that may be available for production, but further context is required in order to understand the magnitude of the stock and for how long the stock might be available.

Q. Which production projections did you examine for the Eastern U.S. Region?

A. I examined the six scenarios projected by the EIA's Annual Energy Outlook 2015 and the other 24 scenarios projected by the EIA's Annual Energy Outlook 2014 (that were excluded in the EIA's shorter 2015 edition) for the Gulf Coast Region. I discuss this geographic area in more detail below. The EIA is specific in that it only produces projections—which are estimates that may occur given specific hypothetical assumptions. Alternatively stated, the EIA does not place any expectation that any one outcome, such as its Reference Case, is any more likely to occur than any of its 29 alternate scenarios. Furthermore, there is no expectation by the EIA that any of the 30 total scenarios will necessarily occur. I used the combination of scenarios to evaluate whether sufficient non-speculative resources exist to fulfill such production and will be available for at least a 35-year horizon.

Q. Why did you separately examine non-speculative resources and compare them to EIA's projections?

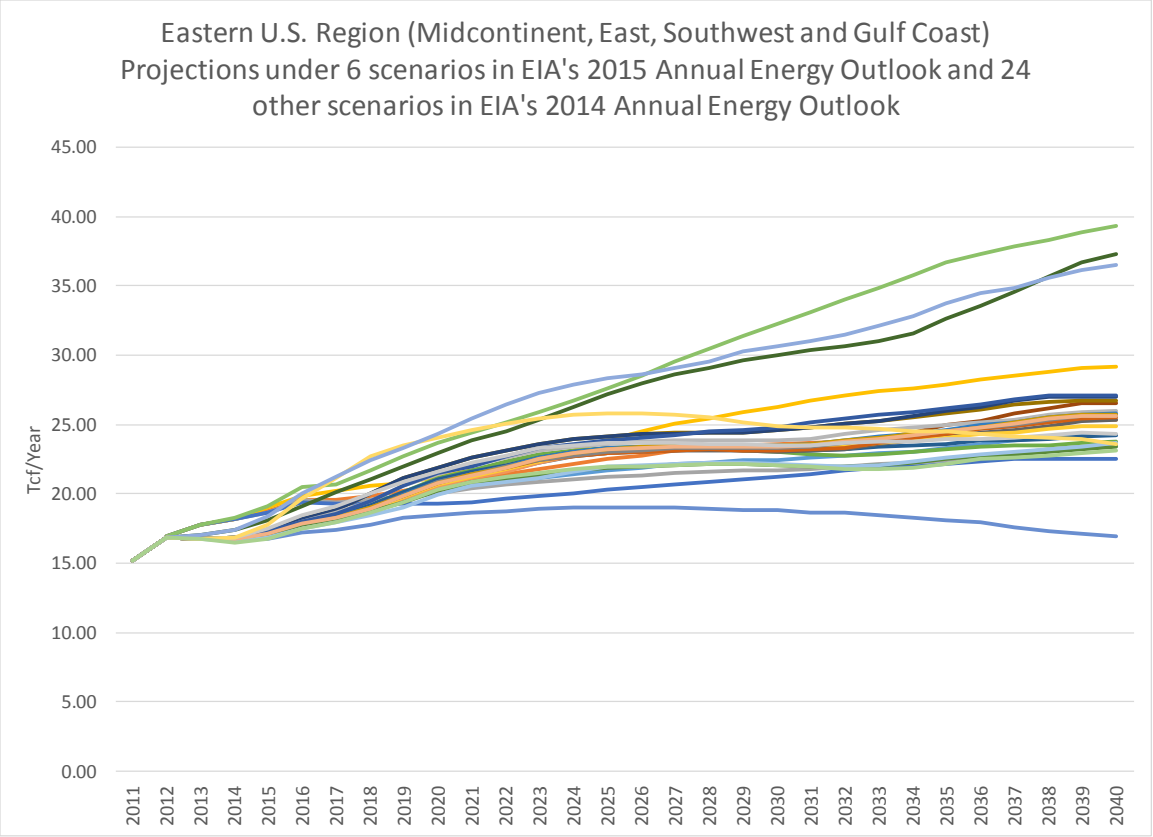
A. The EIA's AEO uses its proven reserves estimates in addition to estimates of "unproven resources," which may include resources that can be classified as speculative. By comparing the EIA's resource projections to the amount of non-speculative resources available in each region, I can ensure that such projections will not require the existence of speculative resources to come to fruition.

Q. How do the EIA regions differ from the PGC regions you used to define the Eastern U.S. Region?

A. There is large overlap. The only substantial amount of land area that is located in the EIA regions that is not located in the PGC regions includes only Western Nebraska. The only substantial amount of land area that is located in the PGC regions and not the EIA regions includes a portion of Eastern South Dakota. Neither of these areas are production areas, therefore the lack of perfect overlap is inconsequential.

Q. What do the Eastern U.S. Region production projections show?

A. I combined the various individual EIA region projections to come up with the production projections for the combined Eastern U.S. Region. The results from the various EIA projections are shown below, each color representing a different scenario (for presentation purposes the scenario labels are not provided below, but can be found in Exhibit No. ANR-038).

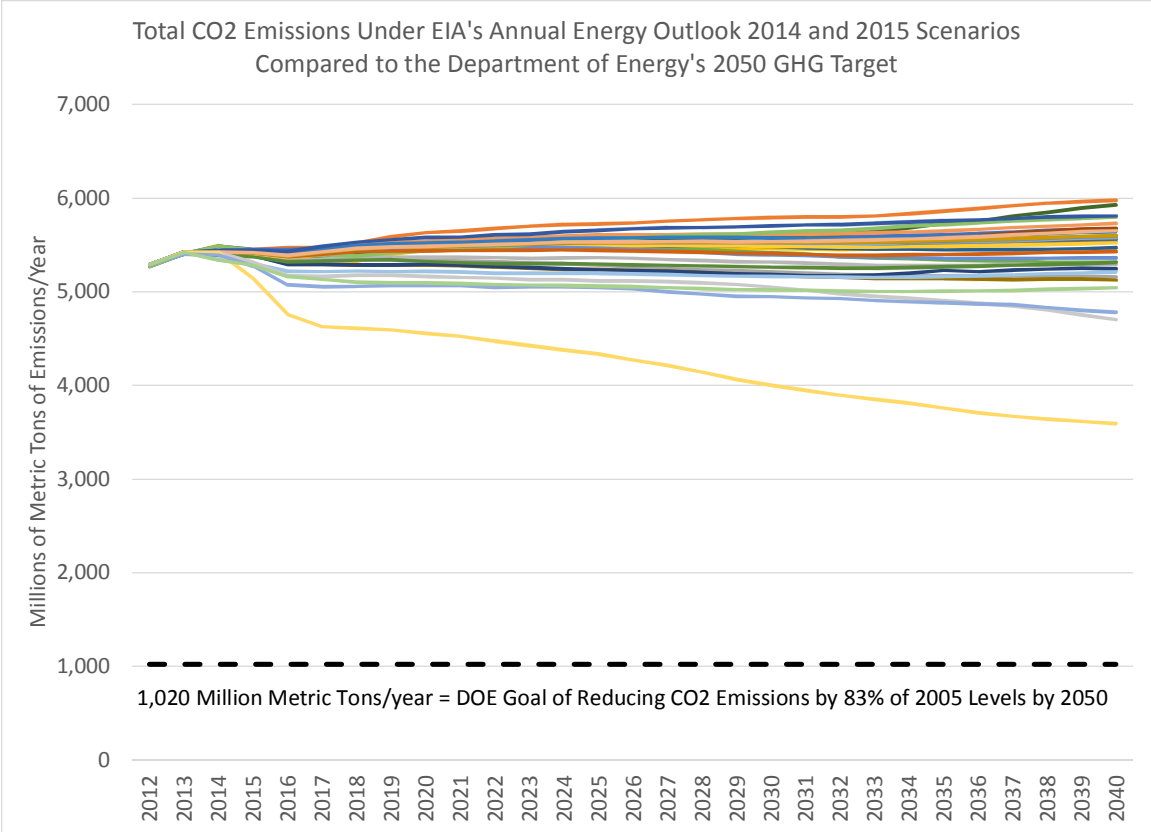


As I explained earlier, the Commission has previously used 35 years for a pipeline's economic life, even when additional years of supplies may have been available. My purpose here is therefore to confirm whether supplies will be available for 35 years. Since the EIA's projections only extend 25 years, I use the annual average growth (or decline) rates of each scenario in its last 5 years to project production for 2040 to 2050, in order to reach 35 years from present day. The total aggregate production from 2013 to 2050 is 1,234 Tcf from the highest-production scenario and 834 Tcf from the Reference Case, which is about 80 percent and 54 percent of the approximately 1,535 Tcf of estimated remaining non-speculative resources in the region. This comparison demonstrates that sufficient levels of non-speculative resources in the Eastern U.S. Region are likely to be available over a 35-year period. It should be noted, however, that factors of demand dis-

cussed in Section III explain why demand for natural gas becomes particularly speculative beyond a 35-year period.

Q. You mentioned that the EIA's figures are projections, and that the EIA does not state an expectation that any particular projection is likely to occur. How do you view the likelihood of the EIA's projections?

A. Due to several considerations of demand discussed in Section III, all of the projections are likely to over-estimate natural gas production in the long-run. For instance, government policy goals regarding energy and the environment could result in the EIA projections overstating the production that will occur. A specific example of such a government policy is the U.S. Department of Energy ("DOE") goal of reducing greenhouse gas emissions by 83 percent of 2005 levels by 2050 (discussed in Section III). As shown in the graph below, it does not appear that the EIA has put forth a scenario that will approach this target (for presentation purposes, the scenario labels are not provided below, but can be found in Exhibit No. ANR-039).



None of these projections reflect the impact of a reduction of CO_2 emissions of 83% by 2050. To the extent that the DOE's goal for reducing greenhouse gases is achieved, this will likely diminish the amount of produced supplies considerably.

Q. What are your primary findings with regard to natural gas supply as it pertains to the ANR system?

A. If demand for the transportation services provided by ANR's system exists, sufficient supply will be available within a 35-year horizon. Factors discussed in Section III and throughout this section make such demand increasingly uncertain, particularly beyond 35 years.

III. DEMAND FOR THE TRANSPORTATION SERVICES PROVIDED BY ANR

Q. Why is it important to consider the demand for the transportation services of ANR?

A. Even if sufficient supplies exist, factors affecting demand may limit the amount of *available* supplies that could be expected to be produced and to flow on ANR. I explain some of the sources of uncertainty of demand for natural gas in the long-run. Conclusions that rely on long-run forecasts must be considered speculative due to these inherent uncertainties over long horizons. It also should be noted that most energy forecasts are limited to approximately a 25-year time frame, which reduces some of the uncertainty that exists in forecasts with a longer horizon. Notably, the EIA Annual Energy Outlook 2014 and 2015 both only project to 2040, a 25-year time frame.

Q. Please explain some of the sources of uncertainty that will influence the demand for the transportation services of ANR in the future.

A. The demand for any good or service is influenced by the prices of alternatives and substitutes, as well as other factors called "demand shifters." The demand for transportation on ANR is a function of the demand for natural gas as a commodity. The future uncertainty about long-run natural gas demand can be tied to three sources: (1) the technological development of alternative energies; (2) potential gains in energy efficiency; and (3) energy and environmental legislation/regulation. While there is less uncertainty in the short-run, large changes can occur in the long-run due to changes in these three areas.

Q. What do you mean by the phrases "short-run" and "long-run"?

A. These terms are economics concepts. The "long-run" refers to a period of time over which no factors of production are fixed. The "short-run" refers to a period of time during which some factors of production may be fixed but others are variable. In the short-run, it is economic to continue to sell a good or service as long as the price is above vari-

able cost, even if the price is not high enough to recover the large "sunk" investments involved in production. In the long-run, since all factors of production are variable, there is flexibility in the mix of energy sources utilized in each region. For purposes of this Prepared Direct Testimony, and consistent with the Commission precedent discussed earlier, I generally refer to a time period of 35 years or more when I refer to the "long-run." A 35-year time period should be sufficient to consider most productive inputs in the economy to be considered variable.

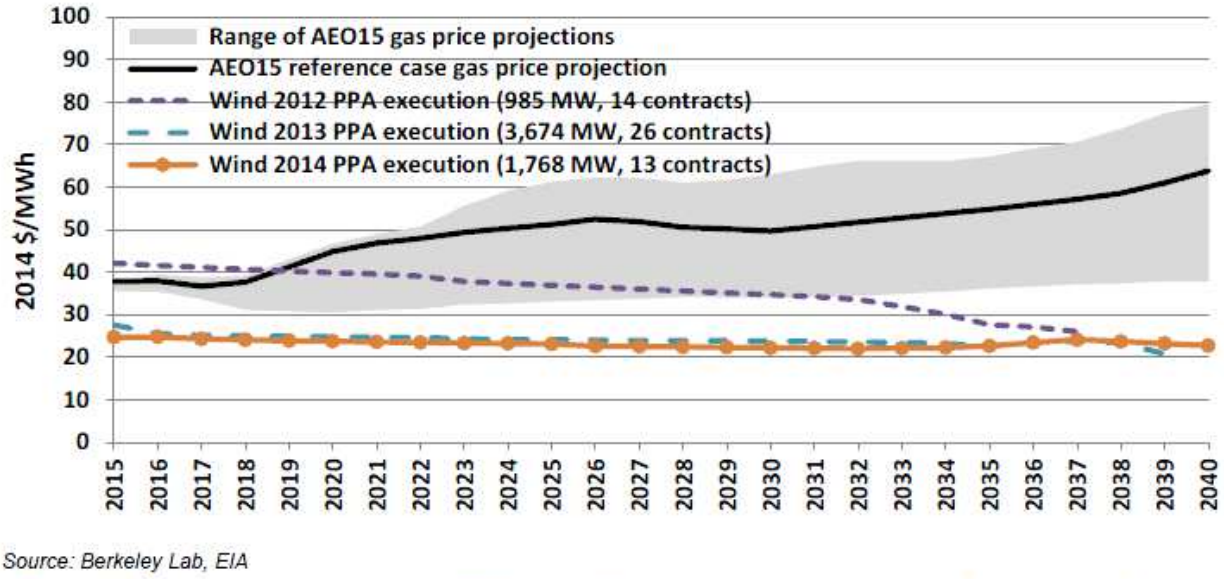
Q. Please explain how technological development of alternative energies and energy efficiency can diminish demand for natural gas in the long-run?

A. As technology advances and the prices of alternative energies decline, alternative energies may become the economic choice for many energy consumers. Alternative energies, such as wind and solar, are likely to offer a viable competitive alternative to natural gas, particularly over a 35-year period. Increases in energy efficiency due to technological development and adoption also may reduce the demand for natural gas over time.

Q. Do you have any recent examples of how advancements in technology have lowered the cost of alternative energy?

A. Yes. Solar power prices, such as from photovoltaic systems, have fallen significantly in the past 20 years. The National Renewable Energy Laboratory ("NREL"), a national laboratory of the DOE, in an August 2015 report titled "Photovoltaic System Pricing Trends," stated "[r]eported system prices of residential and commercial [photovoltaic] systems declined 6%–12% per year, on average, from 1998–2014, and by 9%–21% from 2013–2014, depending on system size," and that "analysts expect system prices to continue to fall." See Exhibit No. ANR-042 at 4 and 28. Wind power prices have also fallen substantially in the recent past. An August 2015 study by the DOE titled "2014 Wind Technologies Report" stated that "wind [power purchase agreement ("PPA")] prices have

reached all-time lows" and that "[t]he continued decline in average levelized wind PPA prices, along with a continued rebound in wholesale power prices, left average wind PPA prices signed in 2014 below the bottom of the range of nationwide wholesale power prices." See Exhibit No. ANR-043 at 4. The DOE provided a comparison of average long-term wind PPAs by vintage as a future stream to the EIA's 2015 AEO natural gas fuel cost projections, shown below.



Source: Berkeley Lab, EIA

Figure 49. Average long-term wind PPA prices (by vintage) and natural gas fuel cost projections over time

As can be seen above, the average PPA price for wind in 2013 and 2014 are below natural gas fuel costs alone, under the EIA's 2015 AEO natural gas price projections. As noted by the DOE, there are a number of caveats to the comparison above. For example, full social costs of natural gas generation are not included, and the wind PPA prices include certain financial incentives. Please see Exhibit No. ANR-043 at 5 for the DOE's full notes.

Q. How might energy and environmental policies impact natural gas demand?

A. Evolving governmental energy and environmental policies may cause significant changes to the energy mix utilized in the United States in the long-run. I will discuss the Endangerment Finding under Section 202(a) of the Clean Air Act, evolving methane regulations, the Clean Power Plan ("CPP") final rule, and the DOE's long-term goal regarding greenhouse gas emissions.

Q. What is the "Endangerment Finding" under Section 202(a) of the Clean Air Act?

A. On December 7, 2009, the U.S. Environmental Protection Agency ("EPA") determined under Section 202(a) of the Clean Air Act that the current and projected concentrations of six key greenhouse gasses in the atmosphere threaten the public health and welfare of current and future generations. The six greenhouse gases listed by the EPA as endangering the public health and welfare include: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The EPA's endangerment finding lays the groundwork for the federal government to regulate these emissions from power plants, factories, automobiles, and other major sources.

Q. How does the "Endangerment Finding" impact the future of natural gas use in the United States?

A. The production and consumption of natural gas involves some of the greenhouse gases mentioned above—namely, methane and carbon dioxide. A web site owned by the Natural Gas Supply Association (http://naturalgas.org/overview/background/) identifies the composition of natural gas:

Typical Composition of Natural Gas

Methane	CH_4	70-90%
Ethane	C_2H_6	0-20%
Propane	C_3H_8	
Butane	C_4H_{10}	
Carbon Dioxide	CO_2	0-8%
Oxygen	O_2	0-0.2%
Nitrogen	N_2	0-5%
Hydrogen sulphide	H_2S	0-5%
Rare gases	A, He, Ne, Xe	trace

According to EPA, lost and unaccounted for gas from, e.g., production and distribution, endangers the public health and welfare and can be regulated under the Clean Air Act. Although natural gas may be considered a relatively clean burning fuel compared to other fuels, the burning of natural gas also produces carbon dioxide and nitrous oxide according to the DOE's website (http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html).

Q. You mentioned that evolving methane regulations cause uncertainty in natural gas demand. Can you discuss how regulations pertaining to methane emissions are evolving?

A. Yes. The DOE has recently announced a number of actions, partnerships, and stakeholder commitments in order to modernize the nation's natural gas transmission and distribution system and reduce methane emissions. *See* Exhibit No. ANR-041 at 1-7. The EPA also announced new measures to cut methane emissions from the oil and gas sector earli-

er this year. *See* Exhibit No. ANR-041 at 8-9. Compliance costs associated with methane regulations will drive economic decisions and may act to increase the relative price of using natural gas compared to alternative fuel sources, thereby creating an additional source of uncertainty in the demand for natural gas.

Q. You have focused on natural gas emissions and have not yet discussed coal. If natural gas use is "cleaner burning" than coal, is it reasonable to expect that natural gas consumption will increase with more environmentally-sensitive regulations, such as the Endangerment Finding?

A. In the short-run, yes. However, the long-run goals of greenhouse gas reduction by the DOE would require a dramatic decrease not only in coal use, but natural gas use as well.

Q. What is the EPA's Clean Power Plan?

A. On August 3, 2015, the EPA announced the CPP. The regulations are meant to reduce the amount of carbon dioxide emitted by power plants under Section 111(d) of the Clean Air Act. *See* 40 C.F.R. Part 60**.** The CPP requires that states reduce carbon dioxide emissions by a total of 32 percent of 2005 levels by 2030. By 2030, under the CPP it is estimated that renewable energy will account for at least 28 percent of U.S. generation capacity. The CPP is an example of how new energy and environmental rules and regulations can increase renewable energy use and, correspondingly, displace demand for other energy sources.

Q. Please discuss the DOE's long-term goal regarding greenhouse gas emissions.

A. The DOE has set a goal of reducing greenhouse gas emissions by 83 percent of 2005 levels by 2050, *see* Exhibit No. ANR-040 at 3. Additionally, a March 31, 2015 press release by the White House mentions that a new 2025 emissions target submitted by the State Department to the United Nations Framework Convention on Climate Change "will keep the United States on the pathway to achieve deep economy-wide reductions of 80 percent

or more by 2050." *See* Exhibit No. ANR-040 at 6-7. Such a goal is likely to require a drastic cut in natural gas use during the next 35 years. While it is true that natural gas use may emit less carbon dioxide emissions than coal, the long-term greenhouse gas emissions goal cannot be achieved without substantial declines in natural gas usage. The data below, from the EIA, shows annual energy-related carbon dioxide emissions from coal, natural gas, and petroleum from 2005 to 2014.

Annual Energy-related Carbon Dioxide Emissions

(million metric tons of carbon dioxide)

Year	Coal	Natural Gas	Petroleum	TOTAL
2005	2,182	1,183	2,623	5,999
2006	2,147	1,168	2,593	5,920
2007	2,172	1,243	2,596	6,023
2008	2,139	1,253	2,437	5,841
2009	1,876	1,230	2,307	5,424
2010	1,982	1,290	2,339	5,623
2011	1,876	1,306	2,304	5,498
2012	1,664	1,364	2,254	5,293
2013	1,722	1,391	2,262	5,375
2014	1,720	1,434	2,250	5,404

Source: http://www.eia.gov/todayinenergy/detail.cfm?id=10691 and http://www.eia.gov/forecasts/steo/tables/pdf/9atab.pdf

Energy-related carbon dioxide emissions in 2005 were 5,999 million metric tons. A reduction of 83 percent of 2005 emissions would require carbon dioxide emissions to be reduced to a total of 1,020 million metric tons (=5,999 * (1- 0.83)). Natural gas-related carbon dioxide emissions in 2014 *alone* totaled 1,434 million metric tons, higher than the

2050 target for *total* energy-related carbon dioxide emissions. Furthermore, even if natural gas emits up to 45 percent fewer carbon dioxide emissions than coal, the conclusion that natural gas use must be significantly reduced to meet the 2050 greenhouse gas standards is unchanged. This is because if all sources of coal-related carbon dioxide emissions were replaced by natural gas with 45 percent fewer emissions, natural gas carbon dioxide emissions alone would equal 2,380 million metric tons (=1,434 + 1,720 * 0.55). This amount is more than twice the 2050 goal of 1,020 million metric tons, which still excludes petroleum emissions, which totaled 2,250 million metric tons in 2014. The DOE's goal of reducing greenhouse gas emissions by 83 percent of 2005 levels by 2050 likely requires a substantial decline in current natural gas use within the next 35 years.

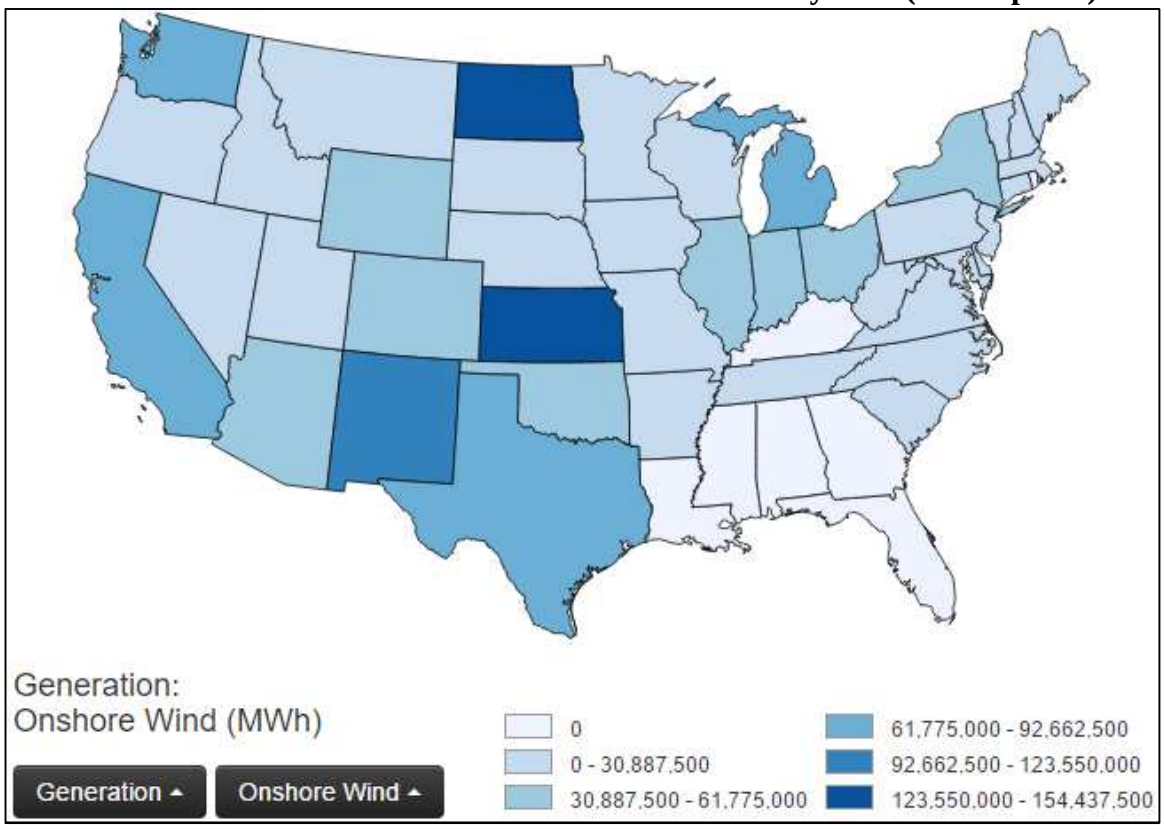
Q. Do you have any estimate of how much natural gas use must fall by 2050 in order to meet the DOE goal?

A. The NREL in 2012 prepared an analysis examining the integration of high levels of renewable electricity into the U.S. electric system. An update of the NREL's analysis in 2014 shows an estimate of how much natural gas-based electricity generation would have to fall by 2050 in order to accommodate an 80 percent decrease in carbon dioxide emissions, which provides insight into how much the demand for natural gas in electricity may drop to meet such goals. The NREL finds that natural gas generation (from both combined cycle and combustion turbine generators) would decrease from 1,265,635 GWh in 2012 to 353,670 GWh in 2050 – a decrease of about 72 percent. *See* Exhibit No. ANR-044 at 1 and http://www.nrel.gov/analysis/re_futures/ for further documentation. Such a large decrease in natural gas use would cause a significant amount of excess pipeline capacity to exist and would greatly impact the ability of pipelines to collect their fixed costs.

Q. Under NREL's scenario that you discussed above, will a significant amount of renewable generation be located across ANR Pipeline's footprint by 2050?

A. Yes, wind generation in particular is projected to be significant across ANR's footprint. The diagram below, prepared by the NREL (see the website in my previous answer), projects the amount of wind generation in 2050 across the United States.

NREL Scenario Results
Projected Wind Generation (GWh) — Incremental Technology Improvement Scenario with 80 Percent Renewable Generation by 2050 (2014 Update)



As can be seen above, a significant amount of wind generation is projected in states traversed by ANR, *e.g.*, Texas, Kansas, Illinois, Indiana, Ohio, and Michigan under this scenario. By 2050, the addition of wind generation and other renewable energy sources (*see* Exhibit No. ANR-044 at 2 for NREL's 2050 projection of generation of all sources under this scenario) may offer significant competition to natural gas across ANR's footprint.

Q. What are your primary findings with regard to natural gas demand as it pertains to ANR?

A. The factors discussed throughout this section cause natural gas demand to be increasingly uncertain, particularly beyond a 35-year horizon.

Q. Does this conclude your Prepared Direct Testimony?

A. Yes, it does.

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

ANR Pipeline Company) Docket No. RP16-____-000

District of Columbia)
) ss.
)

AFFIDAVIT OF ALEXANDER J. KIRK

Alexander J. Kirk, being first duly sworn, on oath states that he is the witness whose testimony appears on the preceding pages entitled "Prepared Direct Testimony of Alexander J. Kirk"; that, if asked the questions which appear in the text of said testimony, he would give the answers that are therein set forth; and that affiant adopts the aforesaid testimony as Alexander J. Kirk's sworn testimony in this proceeding.

Alexander J. Kirk

SWORN TO AND SUBSCRIBED BEFORE ME THIS 26th DAY OF January, 2016

STEPHANIE J. WILKERSON NOTARY PUBLIC MY COMMISSION EXPIRES 6/30/2019 DISTRICT OF COLUMBIA

Notary Public
My Commission Expires:

STEPHANIE J. WILKERSON
NOTARY PUBLIC DISTRICT OF COLUMBIA
My Commission Expires June 30, 2019