Phase III: Natural Gas-Fired Electric Power Generation Infrastructure Analysis Addendum

June 2014

MISO

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1. Executive Summary

The intent of this document is to clarify the representation of the Northern Natural Gas (Northern) pipeline system in the *Phase III: Natural Gas-Fired Electric Power Generation Infrastructure Analysis,* a 2013 study authored by EnVision Energy with support from MISO and sub-contractor Bentek Energy. The Phase III study characterized the northern portion (Market Zones EF) of Northern's system as constrained based on underlying assumptions about natural gas pipeline capacity. Specifically, the report implied that capacity availability for Market Zones EF is 1.7 bcf/d.

Follow-up discussions with representatives of Northern, EnVision Energy, and Bentek Energy, resulted in a better understanding of the operation of Northern's system and a re-characterization of capacity availability to Zones EF of 2.3 bcf/d.

The study takeaways of 1) heavily utilized pipeline capacity in Market Zones EF and 2) need for system expansion given a large increase in demand, such as the interconnection of a 600 MW combined cycle unit, remain; however, Northern Natural Gas representatives have indicated the company's willingness and capability to expand infrastructure to accommodate such increases in demand, with appropriate customer commitments.

2. Background

In December 2013, the *Phase III: Natural Gas-Fired Electric Power Generation Infrastructure Analysis* (Phase III) report[1] was released. This MISO-commissioned study characterized major gas industry trends and provided a high-level picture of gas pipeline capacity availability in the MISO footprint. The Phase III report identified "constrained" areas on the natural gas infrastructure, with the qualification that "each of these constrained areas needs to be understood within the broader context of regional and national pipeline dynamics…"[2]. The natural gas community provided valuable feedback on the results of the analysis, including the conclusions around pipeline capacity availability. Specifically, representatives of Northern Natural Gas (Northern) pipeline commented on the characterization in the study report of capacity on the Northern system.

The addendum was produced in coordination with EnVision Energy (study author), Bentek Energy (sub-contractor to EnVision Energy) and representatives of Northern Natural Gas Pipeline Company.

[1] See https://www.misoenergy.org/Library/Repository/Communication%20Material/Key%20Presentations%20and%20Whitepapers/Phase%20III%20Gas-Electric%20Infrastructure%20Report.pdf.

[2] See page 18 of Phase III report, at link provided in footnote 1.

3. Clarification of Northern Natural Gas Pipeline System Representation

The Phase III analysis identified localized constraints on several natural gas pipelines, including Northern Natural Gas (Northern, also referenced as "NNG" in the Phase III report), as highlighted in the following text from the final report[3]:

> *"NNG is constrained downstream due to the amount of gas it receives from Northern Border at the Ventura Hub to serve its market area. However, the NNG's market area north of the Ventura Hub is capacity constrained for significant power generation and other demand growth and would require significant infrastructure build-out to meet these needs," p63.*
>
> *"...NNG appears to have sufficient capacity into the Midcontinent region. However, if downstream receipts from Northern Border are overlaid on the inflows, it becomes more obvious that the pipe is very highly utilized and constrained on the NNG "branch-systems" in the market region north of Ventura, Iowa," p71.*
>
> *"Both analyses agree that there are no major 'choke' points for gas deliveries to the MISO Midwest forecasted power generator locations except for NNG north of Ventura, Iowa, …" p108.*

These conclusions stem from study assumptions about the movement of gas on Northern's system, as represented in Figure 0-1 (Figure 6-15 in the original report). The Figure includes an overlay of receipts from Northern Border at Ventura onto Northern flows south of the demarcation line (inlaid graphic on Figure 0-1, demarcation or "Demarc" line on Figure 0-2); the implication of this representation is that Northern Border receipts are competing for capacity with flows from the southern portion of Northern's system, to serve demand on the northern portion of Northern's system (i.e. north of the Ventura interconnect). Based on discussions with Northern, a more accurate representation of Northern's system is to separate the supply capabilities of the pipeline system according to Market Zones (Figure 0-2).

[3] See https://www.misoenergy.org/Library/Repository/Communication%20Material/Key%20Presentations%20and%20Whitepapers/Phase%20III%20Gas-Electric%20Infrastructure%20Report.pdf.

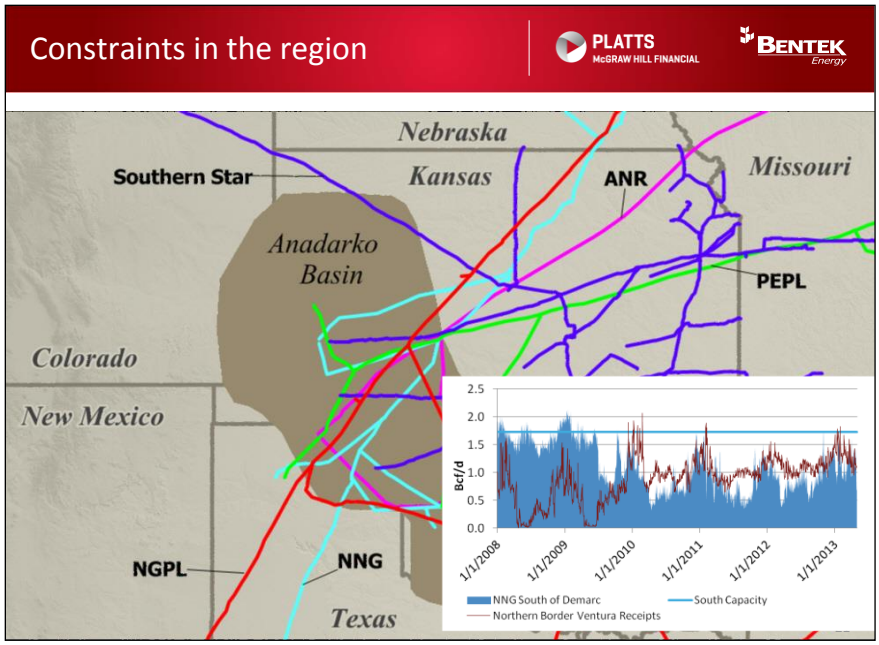

Figure 0-1: Southwest pipeline constraints, NNG and NB (Source: Bentek Energy) (Figure 6-15 in the study report)

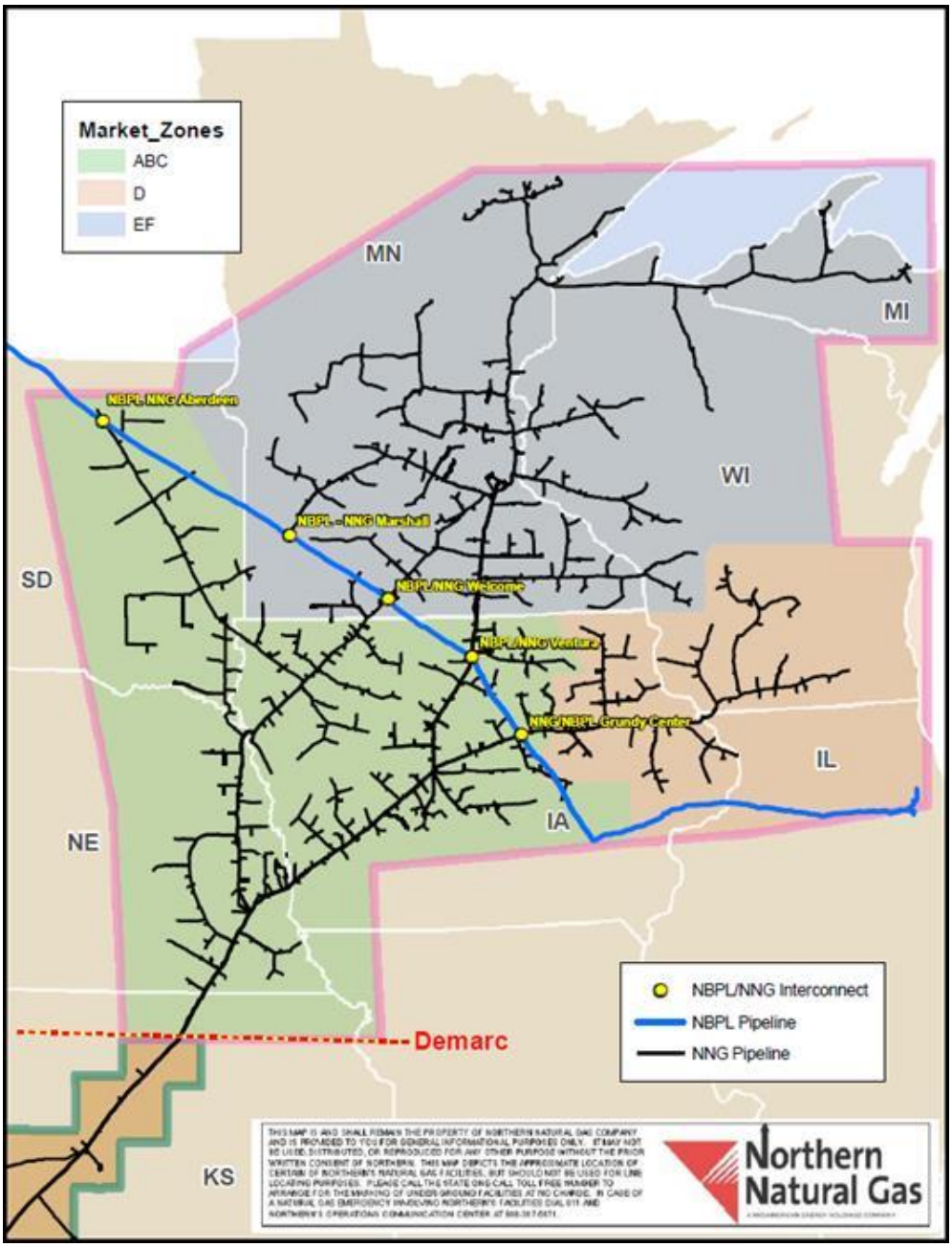

Figure 0-2: Northern Natural Gas Pipeline and Northern Border Pipeline Interconnects (Source: NNG)

Market Zones ABC and D are supplied by volumes from the field area at Demarc and various interconnects with Rockies Express (REX), Trailblazer and Northern Border pipelines. The receipts from these systems should be added to volumes at Demarc to estimate total gas flows to Zones ABC and D. Volumes received at the Aberdeen and Grundy Center interconnects with Northern Border appear to serve isolated demand on the extreme ends of Zones ABC and D. These two interconnects account for

roughly 0.1 bcf/d[4] of total segment capacity. Figure 0-3 illustrates design capacity for Market Zones ABC and D versus historical flows.

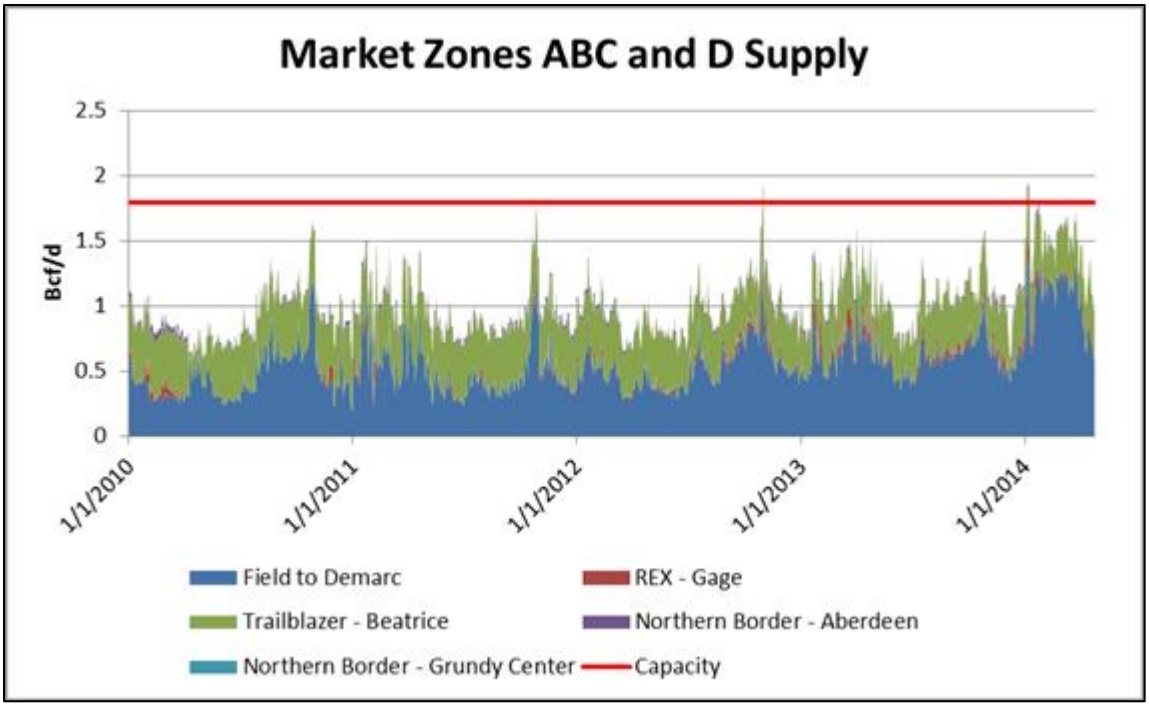

Figure 0-3: Supply sources for NNG Market Zones ABC and D (Source: Bentek Energy)

Market Zone EF is primarily supplied by three interconnects with Northern Border (Marshall, Welcome and Ventura) and Great Lakes Gas Transmission (GLGT) pipeline at the Carlton interconnect near the northernmost portion of the Northern system. The segment capacity of 1.7 bcf/d for gas flowing north at Demarc, as shown on Figure 0-1 is accurate; however, the total capacity available to customers on the northern portion (Market Zones EF) of Northern's system is greater than 1.7 bcf/d.

The main interconnect of Northern with Northern Border is at Ventura (northern portion of Market Zone ABC), with a segment capacity of 2.1 bcf/d north of that point; followed by Welcome (southern portion of Market Zone EF), with a segment capacity of 118 MMcf/d[5] north of the point and an interconnect capacity of 330 MMcf/d. Marshall is a smaller interconnect, similar to Aberdeen and Grundy Center, that serves demand in western Minnesota and has a capacity of 70 MMcf/d.

In total, there is roughly 2.3 bcf/d of segment capacity from these three interconnect points heading north into the Market Zone EF. The interconnect with GLGT near Carlton, MN, can also serve Northern's Market Zone EF because the northern part of the GLGT system is bi-directional. Though the segment capacity south of Carlton interconnect was not specified by Northern, Bentek's data indicates that the most Northern has received from GLGT at that point is just below 0.5 Bcf/d. Figure 0-4 shows the combined capacity and the total supply for Market Zone EF by interconnect.

[4] Bcf/d = billion cubic feet per day
[5] MMcf/d = million cubic feet per day

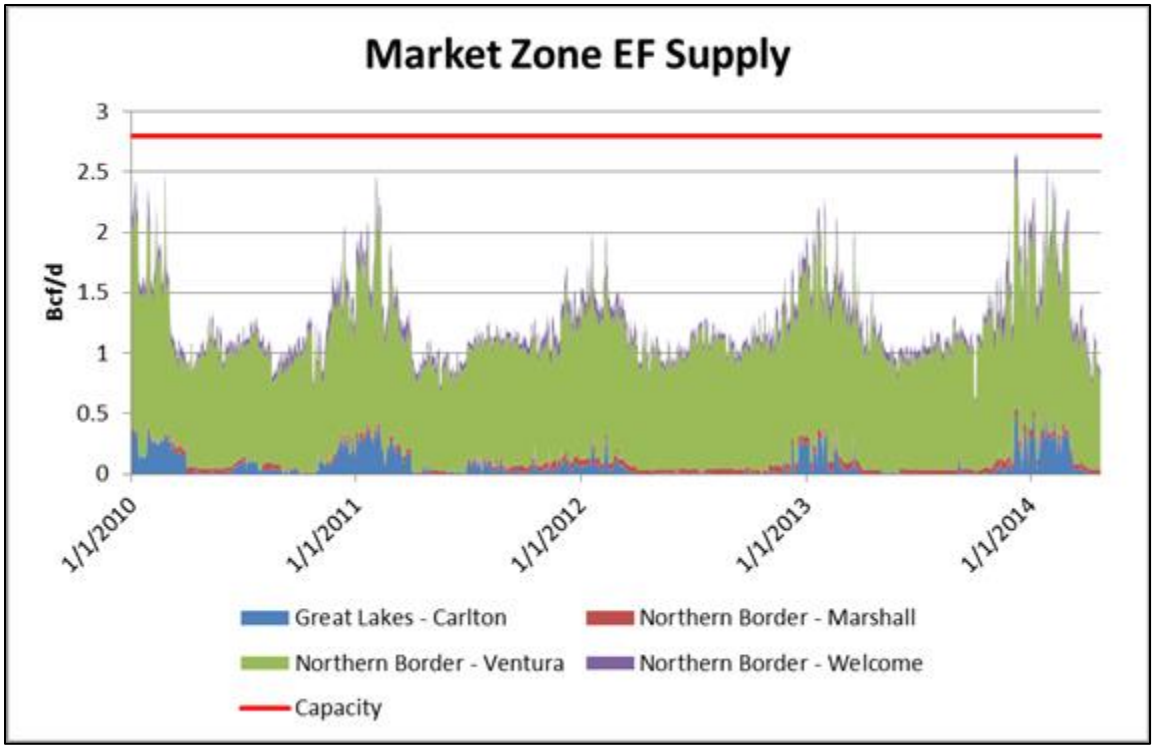

Figure 0-4: Supply sources for NNG Market Zones EF (Source: Bentek Energy)

4. Conclusions

The use of 1.7 bcf/d of pipeline capacity at the demarcation line ("Demarc" on Figure 0-2) to represent total available capacity for the northern Market Zones of Northern's system in the Phase III study was based on a limited understanding of the operation of Northern's system. Through follow-up conversations, it was determined that 2.3 bcf/d is a more accurate figure for total capacity available to Market Zones EF; however, the study conclusion that pipeline capacity in Northern's Market Zone EF is currently heavily utilized and that a large demand increase (e.g. interconnection of a 600 MW combined cycle unit) on Northern would require system expansion, is still deemed appropriate.

The figures cited in this document help to clarify pipeline capacity and historical flows on segments of the Northern Natural Gas (Northern) pipeline, but there are system complexities that make it a challenge to gauge where each molecule of gas is going. Small laterals throughout the Northern pipeline system likely provide additional throughput capacity that may be accounted for by Northern but which cannot be easily verified by external parties. The Ventura and Welcome interconnects serve the northern portion of Northern's system, but they may also flow gas south to meet demand in Zone ABC.

Pipeline functionalities like bi-directionality can increase operational flexibility; they can also add to the challenge of representing gas-electric interactions in analysis and modeling. As the importance of gas as a fuel for electric power generation grows, so does the need for collaboration, of the kind that produced this document, on how natural gas infrastructure operates and interacts with electric infrastructure. This will be essential to ensuring accurate, relevant results from future gas-electric analytical and modeling efforts.

Questions and feedback on the *Phase III: Natural Gas-Fired Electric Power Generation Infrastructure Analysis* can be directed to Greg Peters of EnVision Energy at greg_peters1@verizon.net.