

Eastern Interconnection Planning Collaborative (EIPC)
Statement of Work (SOW)
for the
“Gas-Electric System Interface Study”
for Portions of the
North American Eastern Interconnection

August 2, 2013

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Background

The Eastern Interconnection Planning Collaborative (EIPC) recently conducted bulk electric transmission analysis studies under U. S. Department of Energy (DOE) Cooperative Agreement DE-OE0000343. Subsequent to submitting the draft Phase II report of that analysis, the DOE noted the rapid changes in the natural gas market since the beginning of the study. In particular, the discovery and development of new natural gas resources and the increasing reliance on natural gas for power generation raised a question about the sufficiency of the natural gas infrastructure to support the anticipated need for natural gas power production in the future. As such, the DOE provided the EIPC an extension to perform additional technical analyses to evaluate the interaction between the natural gas and electric systems.

This Gas-Electric Systems Interface Study is designed to provide analysis in sufficient detail to inform the planning, operations and markets (where applicable) of the Participating Planning Authorities (PPAs). In order to evaluate the interaction between the natural gas and electric systems, the study has four main objectives (referred to as Targets): 1) baseline the existing natural gas and electric system infrastructure; 2) evaluate the capability of the natural gas system to meet the needs of the electric system; 3) identify contingencies on the natural gas system that could adversely affect electric system reliability and vice versa; and 4) review dual fuel capability. As such, this study assumes adequate supplies of natural gas are available, and focuses on the interaction of the systems over the next 5 and 10 years in order to coordinate with existing planning authority timeframes, as well as credibly and accurately capture the significant change in generation resource fuel mix that will be occurring in the years 2015-2017 as a result of fuel economics and environmental regulations.

1. Participating Planning Authority (PPA), PPA Area, Study Region, Non-Study Region, Stakeholder Steering Committee (SSC), and PPA Stakeholder Groups

- 1.1 A Participating Planning Authority or PPA is one of the six Planning Authorities that is a participant in this Gas-Electric System Interface Study. The six PPAs are: ISO New England (ISO-NE), New York ISO (NYISO), PJM Interconnection (PJM), Ontario's Independent Electricity System Operator (IESO), the Midcontinent ISO (MISO) (including the MISO South/Entergy system), and the Tennessee Valley Authority (TVA). They are all members of the 26-member Eastern Interconnection Planning Collaborative (EIPC).
- 1.2 The PPA Area¹ is the geographic area served by the PPA. This is the portion of the electric transmission system for which each PPA is the NERC registered Planning Authority.
- 1.3 The Study Region is the portion of the Eastern Interconnection electric transmission system that will be considered in this Gas-Electric System Interface Study along with the natural gas facilities that serve electric generation in that same part of the Eastern Interconnection. It is the collective of all six PPA Areas and the natural gas pipelines that supply these Areas that are included in the study, even if an entire pipeline or facility does not fall within the geographic area served by the PPAs.
- 1.4 The Non-Study Region means a geographic area adjacent to or bordering the Study Region. This Non-Study Region may extend beyond international, state or provincial borders, and is meant to characterize the areas within Mexico, United States and Canada that are not participating within this Gas-Electric System Interface Study. However, natural gas facilities located in the Non-Study Region will be considered as being part of the Study Region, if those natural gas facilities are critical to supplying natural gas to a gas facility located within a PPA Area or the Study Region.
- 1.5 The PPA Stakeholder Groups² are the assembly of stakeholders created by each PPA to provide input to the PPA on its activities and to fulfill any requirements it may have under FERC Order No. 890. Since this Gas-Electric System Interface Study will be performed in a transparent and collaborative manner, the study processes will be open to participation by state and federal officials, representatives from ISOs, RTOs, electric utilities, transmission and generation owners, end-users and relevant stakeholder bodies or non-government organizations (NGO's), including appropriate entities in Canada. Representatives from the North American natural gas industry are also included.

To meet these aforementioned requirements, the EIPC previously established the Stakeholder Steering Committee or SSC, a multi-constituency steering committee, to provide strategic guidance on the scenarios and sensitivities to be modeled, suggested modeling tools, suggest key assumptions for the scenarios and sensitivities, and other activities. The EIPC and SSC Charter and its membership and activities are posted on the EIPC web site which is located at: <http://www.eipconline.com/>.

¹ "Area" is used rather than "region" to avoid confusion with "Study Region" which is defined in SOW Sub-Section 1.3.

² "PPA Stakeholder Group" is used rather than "regional stakeholder group."

2. Consultant Requirements

- 2.1 The term **Consultant** as used within this Statement of Work, is defined as the selected recipient chosen from the candidate(s) or firm(s) who have responded to perform this analysis. The term **Consultant** is interchangeable with **Lead Consultant** or **Technical Consultant**, as may be found throughout other documentation associated with the performance of this project.
- 2.2 A single **Lead Consultant** will be responsible for performing the analysis. This does not exclude a team approach to perform the study services, but where this is the situation or sub-contracting takes place, it must be identified. If a team or sub-contractor approach is utilized, one Consultant shall be designated as the Lead Consultant to which all others report. It will be the responsibility of the Lead Consultant (not the PPAs) to manage the workloads, activities and deliverables assigned to the team(s) or sub-contractor(s).
- 2.3 The Consultant shall possess thorough knowledge of the North American natural gas transportation infrastructure and industry and the North American bulk electrical power systems of the PPAs.
- 2.4 The Consultant shall consider the major natural gas infrastructure and bulk electric systems serving the PPA Areas. In metropolitan areas, the inclusion of local gas distribution companies (LDCs) is an important consideration because such a large number of generating plants are served directly off the LDC systems in those areas.
- 2.5 The Consultant shall possess an exceptional ability to analyze the interactions between natural gas-fired electric generators and the natural gas supply, transportation, and distribution industries.
- 2.6 The Consultant shall demonstrate experience in economic and quantitative analysis of the natural gas and electricity sectors and have the experience with and the capacity to utilize computer simulation techniques including transportation and production cost models.
- 2.7 The Consultant shall demonstrate superior ability to communicate, verbally and in writing, technical information clearly and concisely to both technical and non-technical audiences and to provide deliverables within agreed upon timeframes.

3. Targets

The four (4) targets³ of this Statement of Work (SOW) are to:

1. Develop a baseline assessment that includes descriptions of the natural gas-electric system interface(s) and how they impact each other. Utilizing public information and other appropriate sources of data, compile a baseline of the natural gas and electric system interface(s) within each PPA Area and the entire Study Region (SOW Sections 4 & 5). Assess the specific drivers of the planning process for each of the major pipelines/LDCs in the Study Region, as well as the current level of interaction, at an operational and planning level, between the bulk electric and natural gas systems.
2. By each PPA Area and for the overall Study Region, evaluate the capability of the natural gas system(s) to supply the individual and aggregate fuel requirements from the electric power sector over a five and ten year study horizon under a Reference Gas Demand Case and a High Gas Demand Case. Subject to funding availability, the Consultant will also provide a separate price quote to evaluate the same for a Low Gas Demand Case and other potential sensitivities which the PPAs or the SSC and PPA Stakeholder Groups may choose to exercise.⁴
3. By each PPA Area and for the overall Study Region, identify contingencies on the natural gas system that could adversely affect electric system reliability and vice versa. This contingency analysis shall be performed at the five year study horizon. Subject to funding availability, the Consultant will also provide a separate price quote to evaluate the same type of contingency analysis at the ten year horizon or for other optional sensitivities which the PPAs or the SSC and PPA Stakeholder Groups may choose to exercise.
4. Review operational and planning issues and any changes in planning analysis and operations that may be impacted by the availability or non-availability of dual fuel capability at generating units. This analysis should also review the benefits and costs of requiring dual fuel capacity versus the benefits and costs of gas sector infrastructure expansion. This analysis should also include a review of the siting and/or permitting issues that might affect the feasibility of one solution over the other (e.g. dual fuel versus gas system expansion), or possibly drive an alternative solution.

³ Target – One of the four major areas of work described in the revised Statement of Work that will be completed as part of the Gas-Electric System Interface Study. The term “target” is used rather than goals, tasks, or objectives, which have different meanings within a U.S. DOE cooperative agreement.

⁴ Please note that this analysis is not a national or regional gas supply assessment.

4. Participating Planning Authority Inputs - Baseline the Existing Natural Gas-Electric System Interfaces

Upon execution of this Gas-Electric System Interface Study, the following items shall be complied by the PPAs for their respective PPA Areas and provided to the Consultant for use in this study:

- 4.1. Identification of all gas capable (gas-only and dual fuel) generating units which are 15 MW or greater (or lower capacity units to the extent desired by a PPA) connected to each gas pipeline, and 15 MW or greater located within a gas LDC system.
- 4.2. Within the overall fleet of installed capacity in each PPA Area, identification of the generating units with functional dual fuel capability and their calendar year 2012 capacity factor.
- 4.3. The major assumptions pertaining to the existing and future PPA Area; demand growth, existing/future capacity, transmission expansion, demand response, renewable penetration, imports/exports, and any other relevant assumptions (SOW Sub-Section 6.2).
- 4.4. Included in the future capacity shall be available information regarding the dual fuel capability of future gas capable generation based on ISO/RTO generation interconnection queues and/or governmental requirements, as applicable.
- 4.5. No later than 10/28/13, the PPAs shall deliver to the Consultant, their baseline (SOW Sub-Section 4.1, 4.2, 4.3 and 4.4) of the existing natural gas-electric system interface. The Consultant will review and comment on the PPA Inputs by 11/18/13. The PPAs shall review the Consultants comments and if applicable, subsequently modify their PPA Inputs accordingly. The PPAs and the Consultant shall agree and approve the final PPA Inputs by 12/02/13.

5. Consultant Target 1 - Baseline the Existing Natural Gas-Electric System Interfaces

5.1 Introduction

The purpose of Target 1 is to have the Consultant develop a baseline assessment that includes descriptions and a concise overview of the natural gas-electric system interface(s) and how they impact each other. Utilizing public information and other appropriate sources of data, compile a baseline of the natural gas and electric system interfaces within each PPA Area and the entire Study Region. Assess the specific drivers of the planning process for each of the major pipelines/LDCs within the Study Region, as well as the current level of interaction, at an operational level and a planning level, between the natural gas and bulk electric systems.

5.2 Baseline the PPA Area Natural Gas Systems

By each PPA Area and for the overall Study Region:

- 5.2.1 Identify and tabulate the ownership and locations of all major natural gas facilities. These major facilities should include: interstate and intrastate pipelines, underground storage facilities, above ground LNG/CNG storage facilities, compressor stations, city-gate stations, and gas LDC systems. Identify only those LDCs with gas capable generating units (15 MW or greater) located behind them.
 - 5.2.1.1 Summarize how these natural gas facilities are operated, including any regulatory limitations (e.g., business model and commercial practices). Identify maintenance requirements and expansion (planning) practices. This summary should not be a tabulation of operational guides, maintenance manuals, or tariff sheet language, but a high-level, technical discussion.
 - 5.2.1.2 Include discussion on the new PHMSA regulations (located at: <http://phmsa.dot.gov/pipeline/regs>), with respect to proposing and adopting the rules necessary to comply with the mandates under the 2011 Pipeline Safety Act reauthorization. Discuss potential impacts to the electric sector.
- 5.2.2 Provide a summary discussion of current gas storage and transportation options available to the electric sector, including the impacts of pipeline/LDC tariffs and operational practices on these services, and generator decisions.
 - 5.2.2.1 Provide a summary discussion regarding the four (4) NAESB default nomination/confirmation timelines.
 - 5.2.2.2 Provide a summary discussion identifying all additional/supplemental nomination/confirmation timelines offered by Study Region pipelines or LDCs.
 - 5.2.2.3 Provide a summary discussion identifying all bundled or no-notice gas services and any associated nomination/confirmation timelines offered by the Study Region pipelines or LDCs.
 - 5.2.2.4 Provide a summary discussion of curtailment priorities on pipelines and LDCs in relation to gas capable generating units.
- 5.2.3 For gas capable generating units (as identified and supplied by the PPAs in SOW Sub-Section 4.1), identify their (seasonal) gas contracts by pipeline/LDC tariff or other firm supplier (rate

- schedules/service type), to the extent information is available. Include individual pipeline or LDC tariff sheets for gas supply, storage, transportation and balancing services.
- 5.2.3.1 Identify those gas capable generating facilities that do not have either back-up fuel capability or firm gas delivery agreements.
 - 5.2.3.2 Tabulate that electrical capacity into appropriate gas transportation categories, e.g. no-notice, primary firm, secondary firm, interruptible, etc. Provide a summary discussion of the impacts of pipeline/LDC tariffs and operational practices on these services.
- 5.2.4 Assess and discuss the relative liquidity, availability, and the process of capacity release within the secondary markets.
- 5.2.4.1 Identify and discuss the results of pipeline/LDC experimentation with alternative or supplemental storage, transportation and balancing services.
 - 5.2.4.2 Analyze the availability and liquidity of the capacity release market in each PPA Area and explain the drivers of differences in the availability and liquidity of such markets looking forward.
- 5.2.5. Provide an assessment of the amount(s) and location(s) of any unsubscribed capacity available on the gas pipeline/LDC system(s), taking into account both forward haul and back haul. Identify if any unsubscribed capacity is available only on a “seasonal” basis; i.e., by winter or summer period only.

6. Consultant Target 2 - Evaluate the Capability of the Natural Gas Systems to Satisfy the Needs of the Electric Systems

6.1 Introduction

The purpose of Target 2 is to have the Consultant evaluate the capability of the natural gas system(s) to supply the individual and aggregate fuel requirements from the electric power sector over a five and ten year study horizon under a Reference Gas Demand Case and a High Gas Demand Case, with 2013 being the base year. Subject to funding availability, the Consultant will also provide a separate price quote to evaluate the same for a Low Gas Demand Case and other potential sensitivities which the PPAs or the SSC and PPA Stakeholder Groups may choose to exercise.

6.2 Assumptions

All analyses must be performed for each PPA Area as well as for the overall Study Region. Analyses must be based on realistic and empirically based assumptions and trends, including various levels of economic growth. Please note that this analysis is not a national or regional gas supply assessment. The electric sector analysis should be consistent with the long-range (10-year) forecasts of peak electrical loads, energy demand, economic growth, generating capacity, and transmission system expansion, as published by the PPAs. These assumptions are typically contained within the ISOs/RTOs Regional System Plans (RSPs) or Regional Transmission Expansion Plans (RTEP). The major assumptions pertaining to the electric sector; demand growth, existing/future capacity, transmission expansion, demand response, renewable penetration, imports/exports, among others, shall be compiled by the PPAs for delivery to the Consultant (SOW Section 4.).

The Consultant shall then use these assumptions to develop the five and ten year forecast of fuel requirements for each PPA for all gas capable units. This is usually done using a production simulation model of the electric power grid, but other methodologies can be proposed. Depending on the methodology of the proposed analysis, the fuel delivery pressure requirements of gas capable units may be required as part of this analysis. The PPAs shall provide oversight and guidance to the Consultant during the Consultant's development of the five and ten year fuel requirements for all gas capable units.

The term **fuel requirements** means, at a minimum, the peak hour and 24-hour daily natural gas consumption by gas capable units within the PPA Area or Study Region, and also includes the weekly, monthly, or annual natural gas consumption of those same units. The Consultant shall identify and assess all gas pipelines with gas capable generating units which are 15 MW or greater directly connected and LDC systems with gas capable generating units with are 15 MW or greater located within their service territory.

6.3. Develop a Reference Gas Demand Case that Identifies the Fuel Requirement for all Gas Capable Units

Develop a **Reference Gas Demand Case** that will use "conventional wisdom"⁵ with respect to normal weather and future electric load growth assumptions as provided by the PPAs, consistent with good utility practice. This case will consider seasonal (both summer and winter) demand for natural gas for the electric sector. The Reference Gas Demand Case should also include other "conventional wisdom" type assumptions provide by each PPA, which includes:

⁵ Also referred to as "middle-of-the-road" or "common-sense" type assumption sets.

- 6.3.1 The EIA's Short and Long-Term Energy Outlook (Fuel Price) Forecast for national and regional electric sector fuel prices.
- 6.3.2 Capacity attrition due to economics and/or state, provincial or federally mandated environmental policies.
- 6.3.3 Capacity additions to maintain at least minimum levels of system reliability. This should include projected expansion of energy efficiency (EE), demand-side management (DSM) and/or demand response (DR).
 - 6.3.3.1 In order to assist the PPAs in their projections for the siting of future electrical capacity within the five to ten year timeframe, the Consultant will also identify where gas constraints do not currently exist or may be mitigated by future expansion. Please see SOW Sub-Section 6.10.3.
- 6.3.4 Development of renewable resources to comply with state or federally mandated policies.
- 6.3.5 Development of bulk electrical transmission capacity.
- 6.3.6 Relevant impacts of State Energy Plans to be provided by PPAs.

6.4. Develop a High Gas Demand Case that Identifies the Fuel Requirement for all Gas Capable Units

Develop a **High Gas Demand Case**, which applies extreme weather assumptions and includes higher amounts of natural gas used by the electric sector than the amount(s) assumed to materialize in the Reference Gas Demand Case. All assumptions should tend to drive the overall gas demand from the electric sector to higher levels than the Reference Gas Demand Case. For example, for the natural gas system, the Consultant shall use the gas design day for extreme weather conditions, and for the electric system, the electric conditions coincident with a gas design day shall be used. The assumptions used for SOW Sub-Sections 6.3.1 - 6.3.6, should be revised such that they result in more natural gas being consumed by the electric sector. Identify the incremental gas demands from the Reference Gas Demand Case.

6.5. Develop a Low Gas Demand Case that Identifies the Fuel Requirement for all Gas Capable Units (Optional)

Develop as a separate price quote, a **Low Gas Demand Case**, which applies mild weather assumptions and includes lower amounts of natural gas used by the electric sectors than the amount(s) assumed to materialize in the Reference Gas Demand Case. At the discretion of the PPAs, the work proposed for SOW Sub-Section 6.5 may or may not be completed, and is thus considered an option. All assumptions should tend to drive the overall gas demand from the electric sector to lower levels than the Reference Gas Demand Case. The assumptions used for SOW Sub-Sections 6.3.1 - 6.3.6, should be revised such that they result in less natural gas being consumed by the electric sector. Identify the decremental gas demand from the Reference Gas Demand Case.

Please provide a separate price quote for SOW Sub-Section 6.5 (and subsequently SOW Sub-Sections 6.6 - 6.10). After the draft results and findings of Target 2 are presented to the PPAs, the PPAs will choose whether or not to exercise this option and have the Consultant undertake all or certain activities (SOW Sub-Sections 6.6 - 6.10) associated with the development and analysis of the Low Gas Demand Case.

As part of the development of SOW Sub-Sections 6.3, 6.4, and optional 6.5, the Consultant will work with the PPAs Technical Committee Representatives to develop appropriate assumptions for the cases. Respondents should identify their approach to this aspect of the analysis within their responses to this SOW.

6.6. Analyze Sensitivity(ies) to be Specified by the SSC and PPA Stakeholder Groups in Consultation with PPAs (Optional)

Provide a separate price quote for SOW Sub-Section 6.6. At the discretion of the PPAs, the work proposed for SOW Sub-Section 6.6 may or may not be completed, and is thus considered an option. This price quote will include providing assistance to the PPAs, the SSC, and PPA Stakeholder Groups to develop optional sensitivity(ies). These sensitivities include the same type of analysis as applied under SOW Sub-Sections 6.3, 6.4 and 6.5 and may also include the analysis specified under SOW Sub-Sections 6.6 - 6.10. The Consultant shall provide support to the PPAs, the SSC, and PPA Stakeholder Groups in the development of the optional sensitivities under SOW Sub-Section 6.6.

6.7. Develop Gas Demands for the RCI Sector

For the same five and ten year planning horizon, develop and document the assumptions used to develop forecasts for the Residential, Commercial and Industrial (RCI) sector natural gas demands under similar Reference and High Gas Demand Cases (and Low Gas Demand Case option) assumption sets. The development of the RCI sector's Reference and High Gas Demand Cases gas consumption should take into account the following:

- 6.7.1 Incorporate the currently known and best forecasts for expansion of natural gas sector infrastructure. This typically would include project assumptions concerning gas pipeline expansion, looping, compression, new pipelines, storage, etc.
- 6.7.2 Evaluate LDC load growth and its impact on electric generation needs as well as identify the conditions where those two uses of gas would compete for priority on the natural gas system(s).
- 6.7.3 New (major) RCI projects that may compete for existing or new gas supply and/or transportation.
- 6.7.4 Expansion of LDC service and growth due to conversions from fuel oil to natural gas for space heating. LDC growth should also account for potential growth due to an increased forecast for Combined Heat and Power (CHP) development.
- 6.7.5 Potential reductions in overall natural gas demand within the RCI sector due to economics and/or state or federally mandated natural gas sector EE, DSM, and DR programs.

6.8. Combine Electric and RCI Sector Gas Demands

On the appropriate basis (e.g. by PPA), combine the electric sector fuel requirements (SOW Sub-Section 6.3, SOW Sub-Section 6.4, with the gas demands for the RCI sectors (SOW Sub-Section 6.7). Assess the capability of the individual and overall natural gas system(s) to satisfy the winter and summer electric sector peak demands under the Reference and High Gas Demand Cases. The winter peak electrical demand will assume to take place coincidentally with the winter RCI gas sector peak demand.

6.9. Identify Gas Sector Constraints

Identify by PPA Area or sub-area where gas sector constraints currently exist or might potentially develop in the future, utilizing current gas system capability and known pipeline expansions. Identify by intrastate/interstate pipeline or LDC system, by PPA Area, and throughout the entire Study Region. Identify the type of constraint. Provide analysis and commentary on the number of times per year and/or the duration that these gas constraints are or may be in effect.

- 6.9.1 Identify potential changes to historical pipeline flow patterns due to recent shale gas development in or economically close to each PPA Area (and the Study Region) using different levels of shale gas development at different price levels.

6.10. Determine Possible Mitigation of Gas Sector Constraints

Assess the corresponding need for new gas sector infrastructure (beyond known expansions), services or dual fuel capability to mitigate the gas sector constraints identified in SOW Sub-Section 6.9, while taking into account the following:

- 6.10.1 The Consultant should identify where gas constraints could be caused or exacerbated by existing or future intermittent generation resources and the corresponding need to counter-balance their output with quick-start and fast ramping gas capable generation. Propose mitigation techniques or solution sets from using natural gas supply, transportation, storage, infrastructure expansion or other solutions.
- 6.10.2 The Consultant should identify where gas constraints may be relieved by (proposed) gas system enhancements or projects that are currently under development.
- 6.10.3 The Consultant should also identify where gas constraints do not currently exist or may not exist in the future, in order to assist the PPAs in their projections for the siting of future electrical capacity within the five to ten year timeframe.

7. Consultant Target 3 - Identify Natural Gas System Contingencies that Could Impact Electric System Reliability and Vice Versa

7.1 Introduction

The purpose of Target 3 is to identify severe contingencies on the natural gas system that could adversely affect electric system reliability and vice versa. This contingency analysis shall be performed at the five year study horizon. Subject to funding availability, the Consultant will also provide a separate price quote to evaluate the same type of contingency analysis at the ten year horizon or for other optional sensitivities which the PPAs or the SSC and PPA Stakeholder Groups may choose to exercise.

Members of the SSC and PPA Stakeholder Groups that have been approved and cleared for CEII access may review the lists of identified severe gas and electric sector contingencies to be analyzed. They then may submit to the PPAs and the Consultant, proposed changes (with a description of the reason for the proposed changes) to those contingency lists for potential modification, inclusion or exclusion.

The study shall assess the impacts of severe contingencies on various parts of the natural gas system(s), which will include current system capability and known pipeline expansions, and the impact those contingencies have upon the RCI sector and gas capable generators. The study shall perform analysis that examines the impacts of severe supply or pressure loss on various parts of the natural gas system and the impact of that pressure loss on pressure-sensitive gas capable generators. Likewise, examine and identify the effects that hourly swings from gas capable generation have upon on the reliability of the gas delivery system. Provide commentary, to the extent possible, regarding specific contingency duration and related impacts.

The Consultant shall specify how they intend to perform this contingency analysis, in particular the analytical, numerical, or simulation methods they intend to use to perform the analysis required to satisfy the Target 3 - SOW Section 7. Although the PPAs recognize that hydraulic models of the pipeline systems are particularly suited for this type of analysis, the Consultant may propose cost-effective alternative methods of analysis, provided they can demonstrate that the results and findings will be at least as robust as those that could achieved by using steady-state or transient hydraulic modeling techniques.

By each PPA Area and for the overall Study Region:

7.2 Gas Sector Contingency Analysis

Assess the extent to which natural gas system contingencies within the PPAs Area may impact gas capable generation within that same area and assess the extent to which they may impact gas capable generation located in another PPA Area. Assess the extent to which natural gas system contingencies within the Non-Study Region may impact gas capable generation within the Study Region.

Identify the impacted gas capable units and the expected reduction in terms of operable capacity. Discuss the timing and location of these contingencies. Determine possible mitigation measures.

Under the Reference and High Case Demand Assumptions within Target 2 – SOW Sub-Sections 6.3 and 6.4 – assess the natural gas system(s) at the fifth year study horizon to determine the following:

7.2.1. Loss of gas supply, including gas production, and gathering systems.

7.2.1.1 Assess the potential for and impacts from critical interruptions of gas supply to the power sector, such as those that occurred during the hurricane season of 2005 or the

well-head freeze-offs that occurred in the southwest (ERCOT) in February 2011. Assess the ability of current and future production diversity, brought on by the development of shale gas resources and/or storage capability, to ameliorate these potential gas supply contingencies.

- 7.2.1.2 Other contingencies which represent risks to a non-diverse fuel supply (e.g., loss of LNG imports (due to world-wide pricing differentials) and/or other major supply-chain disruptions).
- 7.2.2 Loss of gas storage facilities, including underground and above ground LNG/CNG facilities.
- 7.2.3 Line breaks or ruptures on trunk-lines, pipelines, laterals or LDC systems.
- 7.2.4 Loss of various levels of pipeline/LDC compression and/or decompression (city-gates).

Please provide a price quote for one additional gas sector contingency analysis under the optional Low Gas Demand Case within Target 2 – SOW Sub-Section 6.5.

Please provide three additional price quotes for gas sector contingency analysis at the ten year study horizon to be optionally completed under 1) the Reference Gas Demand Case (SOW Sub-Section 6.3) at ten years, 2) the High Gas Demand Case (SOW Sub-Section 6.4) at ten years, and 3) the optional Low Gas Demand Case (SOW Sub-Section 6.5) at ten years.

7.3 Electric Sector Contingency Analysis

Assess the extent to which electric system contingencies within the PPAs Area impact the natural gas systems within that same area and assess the extent to which they could impact natural gas systems located in another PPA Area. Assess the extent to which electric system contingencies within the Non-Study Region may impact natural gas systems located within the Study Region.

Identify the impacted natural gas supply, transmission or distribution system(s). Discuss the timing and location of these electric sector contingencies. Determine possible mitigation measures. The analysis shall include:

- 7.3.1 Loss of electrical supply due to electric system outages at the bulk power system level.
- 7.3.2 Loss of or outages of electrically driven pipeline/LDC compressors stations.

7.4 Identify Severe Gas Sector Contingencies (Contains CEII)

- 7.4.1. In consultation with the PPAs, the Consultant shall make a determination of the top three to five most severe gas sector contingencies (in terms of loss of gas capable generation). This information shall be classified *Critical Energy Infrastructure Information (CEII) or in the case of Ontario data, will conform to requirements of the Canadian Security of Information Act.*
- 7.4.2 Using the results of the gas sector contingency analysis (SOW Sub-Section 7.4.1), determine possible mitigation measures, including operational, planning and policy initiatives, to improve the reliability of gas capable generation that are critical to electric system reliability and that are susceptible to these severe gas sector contingencies. Discuss the pros and cons of potential individual solutions or a portfolio of solution sets with respect to improving the availability of gas capable generating resources.

7.5 Identify Severe Electric Sector Contingencies (Contains CEII)

- 7.5.1. In consultation with the PPAs, the Consultant shall make a determination of the top three to five most severe electric sector contingencies (in terms of loss of natural gas system components,

i.e. supply, transmission, and distribution). This information shall be classified *Critical Energy Infrastructure Information (CEII)* or in the case of Ontario data, will conform to requirements of the *Canadian Security of Information Act*.

- 7.5.2 Using the results of the electric sector contingency analysis (SOW Sub-Section 7.5.1), determine possible mitigation measures, including operational, planning and policy initiatives, to improve the reliability of natural gas system components that are susceptible to these severe electric sector contingencies. Discuss the pros and cons of potential individual solutions or a portfolio of solution sets with respect to improving the availability of natural gas system components.

8. Consultant Target 4 - Review Dual Fuel Capability

8.1 Introduction

The purpose of Target 4 is to review the different operational and planning issues related to dual fuel capability, which is the ability of an electric generating unit to operate on more than one fuel type (i.e. gas and oil). This also includes the co-firing of two fuels at once, of which one of the fuels is natural gas.

Review operational and planning issues and any changes in planning analysis and operations that may be impacted by the availability or non-availability of dual fuel capability at generating units. This analysis should also review the benefits and costs of requiring dual fuel capacity versus the benefits and costs of gas sector infrastructure expansion, by specific pipeline or LDC. This analysis should also include a review of the siting and permitting issues that might affect the feasibility of one solution over the other (e.g. dual fuel versus gas system expansion), or possibly drive an alternative solution.

8.2 Assess and Document Dual Fuel Issues

By each PPA Area and for the overall Study Region, the Consultant shall assess and document:

- 8.2.1. For the list of dual fuel generators supplied by the PPAs (SOW Section 4), identify the liquid fuel storage capability at each site or station and identify the method of liquid fuel resupply (i.e., liquids pipeline, nearby oil storage terminal, barge, truck, etc).
- 8.2.2. Identify the operating characteristics of new plants, as referenced in SOW Sub-Section 6.3.3, with respect to burning natural gas and petroleum fuels (including “switch on the fly” capability). Assess whether there are any regulatory or other barriers, such as operating permit restrictions on air or water emissions, which limit gas capable generators’ ability to burn alternate fuels.
- 8.2.3. The market availability of petroleum fuels and (re)supply options. Assess the electric sector’s liquid fuel specifications and discuss the superior requirements from newer generators. Assess the liquid fuel markets and the availability of liquid fuel storage capability at generation sites or nearby (SOW Sub-Section 8.2.1).
- 8.2.4. The low pressure sensing capabilities of gas capable generators that will cause a gas-only generator to be derated or trip offline or a dual-fuel generator to switch to alternative fuel. Identify the reaction time required by different types of generators to successfully switch to alternative fuels.

8.3 Compare Tradeoffs Between Dual Fuel Versus Gas System Expansion

By each PPA Area and the overall Study Region, the Consultant shall extend the analysis in SOW Sub-Sections 6.9 & 6.10, which identifies the existing and potential future constraints within natural gas system(s); identify the tradeoffs between alleviating electric sector fuel constraints with additional gas sector infrastructure or with dual fuel capability.

9. Other Key Assumptions

The following other key assumptions have been made by the PPAs and are to be included within the analysis:

- 9.1. Assume there are adequate natural gas supplies both within and at the PPA Area boundaries, which are able to fill each gas sector facility to its rated seasonal capacity. This is not a national or regional gas supply assessment.
- 9.2. Assumptions with respect to the level of gas in storage facilities (both underground and aboveground (LNG/CNG)) within the PPA Area and the Study Region are to be specified by the Consultant. The Consultant is also expected to assess and forecast the future levels of LNG imports and exports at each individual LNG import/export facility.
- 9.3. Publically available data sources and other public studies will be utilized to the maximum extent practicable in carrying out this analysis. If publically available information is not available to assess, forecast or project future operating, market, or regulatory conditions necessary to accurately perform this analysis, the Consultant is expected to contact and work with the owners/operators of both gas/electric infrastructure in order to ascertain such information for incorporation into this analysis.
- 9.4. If confidential or proprietary data is required by the Consultant to perform any portion of this assessment, the Consultant must identify what that data are, its origin, its vintage, and its projected use within the analysis. The Consultant shall propose how confidential or proprietary data will be obtained, handled, redacted, labeled and protected.
- 9.5. The EIPC's Coordination and Technical Committees will provide oversight, guidance, and direction with respect to execution of this analysis.
- 9.6. Assume all new gas capable power plants will be single fuel, gas-only generating units unless dual fuel capability has been proposed.

10. Consultant's Deliverables - Presentation of Results and Findings

10.1 Confidential and CEII Materials

The PPAs and the Consultant will identify and correspondingly redact or appropriately label those sections of the *Draft* and *Final Reports* and *Presentations* that are deemed classified as either *Confidential - (Redaction)* or *Critical Energy Infrastructure Information (CEII) - (Labeling)*. This *Confidential* or *CEII* information *must be redacted or labeled* within the *Draft* and *Final* versions of the *Reports* and *Presentations* prior to any document, report, presentation or other work product(s) being released into the public domain.

10.2 PPA Comments

At a time that is mutually agreeable to both the PPAs and the Consultant, the Consultant shall hold a webinar to provide details on their approach and sources of assumptions as each Target is undertaken. Additionally, the Consultant shall deliver a Draft Report and Presentation for each of the four SOW Targets (1-4) to the combined PPAs and/or the individual PPAs on the draft results and findings of the analysis. The PPAs will work with the Consultant to minimize the number of presentations, which could be as high as six (6), or one for each PPA per Target. The PPAs shall be given sufficient time and opportunity to review and comment on the Consultant's Draft Report and Presentation. The PPAs shall review and return all of their comments to the Consultant by the dates specified. The Consultant shall incorporate all of the PPAs comments and suggestions, or provide an explanation of why the specific comments were not incorporated. The Consultant shall then produce a Revised Draft Report and Presentation for review by the SSC and PPA Stakeholder Groups. No later than the dates specified, the Consultant shall deliver the Final Report and Final Presentation to the PPAs. The Final Presentation shall reflect the results and findings as contained within the Final Report.

10.3 SSC and PPA Stakeholder Groups Comments

At a time that is mutually agreeable to both the PPAs and the Consultant, the Consultant shall hold a webinar to provide details on their approach and sources of assumptions as each Target is undertaken. Additionally, the Consultant shall deliver a Revised Draft Report and Presentation for each of the four SOW Targets (1-4) to the SSC and the PPA Stakeholder Groups. The PPAs will work with the Consultant to minimize the number of presentations, which could be as high as seven (7), or one for each PPA Stakeholder Group and the SSC per Target. The SSC and PPA Stakeholder Groups shall be given sufficient time and opportunity to review and comment on the Consultant's Revised Draft Report and Presentation. The PPAs shall take all stakeholder comments and suggestions into consideration and subsequently provide the Consultant with a final set of comments for incorporation into the Final Report and Final Presentation. The Consultant shall also provide support to the PPAs, the SSC, and PPA Stakeholder Groups in the development of the optional sensitivities under SOW Sub-Section 6.6.

10.4 Consultant Deliverables Timelines

10.4.1 SOW Section 5. – Consultant Target 1 - Baseline the Existing Natural Gas-Electric System Interfaces

No later than 12/20/13, the Consultant shall deliver a Draft Report and Draft Presentation, including graphic representation of gas demand, for SOW - Section 5 to the PPAs for preliminary review and comment. The PPAs review and return all

comments to the Consultant by 01/03/14. The Consultant shall then produce a Revised Draft Report and Presentation by 01/10/14 for review by the SSC and PPA Stakeholder Groups. The SSC and PPA Stakeholder Groups will provide comments on the Revised Draft Report and Presentation by 01/31/14. The PPAs shall take all stakeholder comments and suggestions into consideration and subsequently provide the Consultant with a final set of comments for incorporation into the Final Report and Final Presentation by 02/14/14. The Final Report and Final Presentation shall be delivered to the PPAs by 02/21/14.

10.4.2 SOW Section 6 - Consultant Target 2 - Evaluate the Capability of the Natural Gas Systems to Satisfy the Needs of the Electric Systems

No later than 03/28/14, the Consultant shall deliver a Draft Report and Draft Presentation, including graphic representation of gas demand, for SOW - Section 6 to the PPAs for preliminary review and comment. The PPAs review and return all comments to the Consultant by 04/11/14. The Consultant shall then produce a Revised Draft Report and Presentation by 04/18/14 for review by the SSC and PPA Stakeholder Groups. The SSC and PPA Stakeholder Groups will provide comments on the Revised Draft Report and Presentation by 05/09/14. The PPAs shall take all stakeholder comments and suggestions into consideration and subsequently provide the Consultant with a final set of comments for incorporation into the Final Report and Final Presentation by 05/23/14. The Final Report and Final Presentation shall be delivered to the PPAs by 05/30/14.

10.4.3 SOW Section 7 – Consultant Target 3 - Identify Natural Gas System Contingencies that Could Impact Electric System Reliability and Vice Versa

No later than 09/12/14, the Consultant shall deliver a Draft Report and Draft Presentation for SOW - Section 7 to the PPAs for preliminary review and comment. The PPAs review and return all comments to the Consultant by 09/26/14. The Consultant shall then produce a Revised Draft Report and Presentation by 10/03/14 for review by the SSC and PPA Stakeholder Groups. The SSC and PPA Stakeholder Groups will provide comments on the Consultant's Revised Draft Report and Presentation by 10/24/14. The PPAs shall take all stakeholder comments and suggestions into consideration and subsequently provide the Consultant with a final set of comments for incorporation into the final Report and Final Presentation by 11/07/14. The Final Report and Final Presentation shall be delivered to the PPAs by 11/14/14.

10.4.4 SOW Section 8 – Consultant Target 4 - Review Dual Fuel Capability

No later than 05/23/14, the Consultant shall deliver a Draft Report and Draft Presentation for SOW - Section 8 to the PPAs for preliminary review and comment. The PPAs review and return all comments to the Consultant by 06/06/14. The Consultant shall then produce a Revised Draft Report and Presentation by 06/13/14 for review by the SSC and PPA Stakeholder Groups. The SSC and PPA Stakeholder Groups will provide comments on the Consultant's Revised Draft Report and Presentation by 07/04/14. The PPAs shall take all stakeholder comments and suggestions into consideration and subsequently provide the Consultant with a final set of comments for incorporation into the Final Report and Final Presentation by 07/18/14. The Final Report and Final Presentation shall be delivered to the PPAs by 07/25/14.

{End of Statement of Work}