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Exhibit Reference: SCG-09

Subject: RD&D

Please provide the following:

1. Is SCG aware of other entities conducting studies on testing, monitoring and removal of harmful constituents in biomethane? (GAW-A4).

SoCalGas Response:

SoCalGas actively reviews independent studies and supports research to identify and analyze trace constituents in biogas that maybe harmful to our pipeline infrastructure, end-use equipment, and public/employee health. SoCalGas has found it beneficial to participate in industry collaborative projects, such as through the Operations Technology Development (OTD) and the American Gas Association programs, to gain access to the most up-to-date information.

For example, OTD used the Gas Technology Institute's (GTI) performing laboratories and scientists to identify trace constituents of concern in biomethane from dairy waste, which resulted in a GTI published report, "Guidance Document for Introduction of Dairy Waste Derived Biomethane into Existing Natural Gas Networks". Using a similar approach, GTI is currently working on a follow on Guidance Document for landfill derived renewable gas. Another OTD project, "Assessing Acceptable Siloxane Concentrations in Biomethane", will provide the gas industry with guidance on acceptable levels of Siloxane in biomethane to minimize or eliminate adverse performance impacts on combustion equipment.

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2. Why is SCG uniquely suited to meet the "urgent need" to develop technologies for inspecting external corrosion and problem areas for difficult to access, 12" to 36" cased pipelines? (GAW-A5).

SoCalGas Response:

The urgency stems from a federal requirement (CFR 49, Part 192, Subpart O[1]) to inspect transmission pipelines in high consequence areas by 2012. Additionally, we also ensure the safe operating condition of other transmission pipelines located outside of high consequence areas. SoCalGas primarily utilizes conventional pigging technology and External Corrosion Direct Assessment (ECDA) to generate inspection data to identify corrosion and other anomalies. Cased pipelines are frequently situated in elevated highway and road crossings that are inaccessible and problematic for the ECDA process. These cased systems can be exposed to water, liquids or moisture that can enter the annular space between the carrier pipe and casing, and the exposure to liquids can potentially lead to external corrosion issues on the carrier pipe. Telescoping pipeline diameters, low gas flow or pressure, "sharp" bends or other physical obstructions, and the inability to tolerate service interruptions often prevent passage of conventional pigging tools and renders these segments unpiggable. These difficult to inspect systems are prevalent within the congested urban service territory, and create the opportunity for technology development uniquely suited to address these concerns.

SoCalGas has actively participated in collaborative research efforts with other interested utilities to fund the development of a robotic inspection system for unpiggable and inaccessible pipelines. A robotic probe with a mini camera to inspect the annular spaces at cased crossings has also been developed to enhance the ECDA process. The wide use of conventional in-line inspection provides SoCalGas with unique opportunities related to pipe access for testing, operational experience, and data management to assist with the advancement of these experimental tools. In 2010, SoCalGas conducted a field test of a robotic inspection system to gain experience with effective deployment and operation of such a system, as an alternative to conventional pigging systems. Follow-on research and development is underway to enhance the robotic platform capabilities beyond Magnetic Flux Leakage (MFL) measurements, including crack detection and dent sizing – both of which are vital aspects of the overall Integrity Management Plan.

[1] http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=b6956ffd47e214eb0da4dab0831701a5&rgn=div6&view=text&node=49:3.1.1.1.4.15&idno=49

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3. Is existing retrofit equipment for "vintage or 'legacy' gas engines installed at SCG's critical gas transmission stations" insufficient to meet existing air quality regulation requirements? Please provide supporting documentation. (GAW-A5).

SoCalGas Response:

SoCalGas has been using gas driven engine compressors at its Transmission and Storage stations that were installed in the 1950s and 1960s. Although modifications have been made to these engines in order to meet past emission standards, we are unable to meet the constantly changing and ratcheting down of the emission limits with the installed technologies. SoCalGas is participating in a multi-year research project at Pipeline Research Council International, Inc. to develop retrofit equipment capable of achieving lower emissions limits.

We are adding oxidation catalysts on lean burn engines under the Southern California Air Quality Management District's (SCAQMD) Rule 1110.2. The attached variance petition shows that even though we followed the mandates of the SCAQMD, we were not able to achieve the lower limit of the rule. More research is needed in this area to fully understand the capabilities of the catalysts in these applications.


VOC Limits Variance.pdf

State of the art retrofit control technology for modern gas engines can reach NOx levels of 2-3 g/BHP-hr (~ 120 - 180 ppm), required under District rules. Some of our older, legacy engines have difficulty attaining these lower emission limits for NOx, and many more will have difficulty as the limits drop farther. For example, the Bay Area Air Quality Management District (BAAQMD) has rules that are significantly more stringent and limits that cannot be achieved for our engines under existing conditions. We will be very challenged if Mojave District adopted similar limits. Research funding to develop technologies, customized to meet our needs, will be helpful to demonstrate compliance efforts with air districts. Improved technologies and diagnostics are also needed for continued compliance assurance.


BAAQMD Regulation 9 Rule 8.pdf

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4. Please explain how, given that "CHP is the most energy efficient and cost-effective form of distributed generation," there is insufficient funding for improving CHP technology absent SCG investment. (GAW-A14).

SoCalGas Response:

SoCalGas' investment is needed to steer equipment manufacturers' RD&D efforts to tailor their technologies to meet unique market requirements in Southern California in part due to stringent air quality standards and aggressive energy efficiency goals.

Although gas engines are not new, the current products in the market don't meet CARB 2007 or the SCAQMD emissions requirements for distributed generation or CHP. All of SoCalGas funding for rich-burn gas engines is focused on developing products and technologies that can meet the NOx and CO emissions requirements, which are the most stringent in the world. Most manufacturers of rich-burn gas engines are very large and mainly focused on global markets and they tend to ignore the small market niche in southern California. Our RD&D efforts will help develop new cost effective and durable controls that can be added to existing and new engines to meet these emission requirements. Since 2008, when the California Air Resources Board imposed their new emissions requirements, there are no rich-burn engine products in the market consistently able to meet the requirements in a cost effective manner.

Although Microtubines can meet the emissions requirements for Southern California, they are not very efficient. Our RD&D efforts on Microturbine***s*** are focused on developing the next generation of high efficiency machines. The goal is to increase the efficiency from 28% and below to over 40%.

In addition to funding low emissions and high efficient engines, microturbines and fuel cell***s***, we are also funding several CHP packages that incorporate power generation with heat recovery to achieve a combined heat and power output. New heat recovery technologies, such as an Organic Rankine Cycle, use the exhaust from an engine and/or Microturbine, and produce additional electric power to achieve an overall CHP system efficiency in excess of 75%. There is a need to demonstrate different CHP packages in various commercial applications, such as hotels, schools, hospitals, and buildings, and integrate it with existing energy management systems.

Finally, the SoCalGas RD&D program will help to ensure technologies are available for deployment in support of Governor Jerry Brown initiative to deploy 12,000 MW of DG and 6,500 MW of CHP by 2020, and play a critical role in achieving the Net Zero Energy goals.

The RD&D effort for Fuel Cells is addressed in the response to Question 5.

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5. Please explain why, given that "Fuel cells have been under development for decades" and are "still heavily dependent on state and federal subsidies to make the payback period attractive to customers" ratepayers should continue contributing to Fuel Cell technology. (GAW-A21).

SoCalGas Response:

Fuel cells continue to perform well in the field. There are many benefits to ratepayers when they choose to adopt a fuel cell into their energy mix: greatly reduced emissions, increased electrical efficiency, the opportunity to use it in a cogeneration mode, and reduced noise, among others. However, the capital cost of the units needs to come down to make them more attractive to residential as well as small commercial and industrial customers. One of the primary methods of doing this is to increase production to obtain economies of scale. However, since the units are not in wide use now, the potential customer must be convinced that fuel cells are a safe and reliable technology. One of the most effective methods for doing this is to demonstrate the units in "real world" applications. To help accomplish this, SoCalGas' supporting demonstrations in a variety of commercial, industrial, and residential sites. Additionally, SoCalGas is supporting RD&D to develop fuel cells in sizes that are not currently available. SoCalGas believes this will increase market adoption, and lead to more ratepayers able to benefit from placing fuel cells in their home or business. Currently, even after factoring incentives such as the Investment Tax Credit and Self Generation Incentive Program, fuel cell distributed generation is still more expensive than alternative technologies, such as internal combustion engine and micro turbines. When the fuel cell capital costs are low enough to compete with other distributed generation technologies without incentives, RD&D funding will have accomplished its objectives and will no longer be needed.

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6. Provide a proposed budget for the proposed $1.5-$3.0 million biogas upgrading system for which SCG is asking for $850,000. Include projected contributions from other project funders. (GAW-A31).

SoCalGas Response:

Biogas Upgrading Demonstration System ($000)	
Equipment	2,000
Instumentation	200
Installation	400
Annual Operating Costs	200
Lab Services	100
Consulting Engineering	100
	3,000

Cost Sharing ($000)	
SCG	850
DOE	1,000
EPA	1,000
Customer Host	150
	3,000

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7. Provide a proposed budget for the proposed thermal pyrolysis, gasification and syngas conversion project for which SCG is asking for $705,000. Include projected contributions from other project funders. (GAW-A31).

SoCalGas Response:

Thermal Pyrolysis, Gasification, Syngas, Methanation ($000)	
Gasification Equipment	10,000
Syngas Upgrading	2,000
Methanation	3,000
Interconnection	3,000
Instumentation	200
Installation	700
Annual Operating Costs	200
Lab Services	100
Misc	5
Consulting Engineering	500
	19,705

Cost Sharing ($000)	
SCG	705
DOE	8,000
Vendor	10,000
Customer Host Site Existing Biomass Handling System	1,000
	19,705

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8. Provide support for the statement that, "Without a SCG RD&D effort this valuable [biomass] resource will continue to be wasted." (GAW-A33).

SoCalGas Response:

Biomass is abundantly available, but relatively untapped as an energy resource in California. The California Energy Commission has provided the following estimates of our bio-energy resource.[2]

> Biomass in the state totals 83 million gross bone dry tons per year (BDT/y) at present and is projected to increase to 98 million BDT/y by 2020. Biomass considered to be available on a technically sustainable basis totals 32 million BDT/y in 2007, increasing to 40 million BDT/y in 2020. Of the gross resource in 2007, 21 million tons are from agriculture, 27 million from forestry, and 36 million tons from municipal wastes exclusive of waste in place in landfills and biomass in sewage. The current technical potential includes more than 8 million BDT/y in agriculture, 14 million BDT/y in forestry, and 9 million BDT/y in municipal wastes. Through 2020 the largest resources for development will be municipal solid waste, in-forest biomass, animal manures, landfill gas, orchard and vineyard residues, and field crop residues. State biomass resources are sufficient to supply a substantially larger amount of renewable electricity than is presently generated as well as serving as feedstock for biofuels and bioproducts.

Through 2009, two solid-fuel biomass operators have idled their facilities, and one was shut down due to poor economic conditions in the lumber industry and low contract prices for energy. Four additional solid-fuel biomass facilities idled in 2010, one of which restarted operations in the summer of 2010. Seven dairy manure digesters also idled because of financial difficulties and their inability to meet San Joaquin Valley Air Pollution Control District NOx emission standards. The capacity idled since 2006 is 60 MW, which represents the potential to generate 370 GWh per year of biomass generation.[3] The fundamental problem with current biomass and biogas systems is that they rely exclusively on on-site combustion (i.e., output methane is used at or near the host facility for electric generation or other thermal processes). This inherently dirty, difficult to permit process is severely limiting the development of bioenergy in the state.

Unfortunately, bioenergy projects that produce pipeline quality methane for pipeline injection are at present nonexistent in California. There are no commercial biomass thermochemical conversion (gasification) plants operating in California. There are no biomass methanation plants operating in California. Much of the biogas produced at waste water treatment plants and landfill facilities is being flared.

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[2] Williams, R.B., An Assessment of Biomass Resources in California, 2007, California Biomass Collaborative, (Sacramento, CA 2008) p. iv.
[3] California Energy Commission for the Bioenergy Interagency Working Group, 2011BioenergyAction Plan (Sacramento, CA December 2010) p. 12

Response to Question 8 (Continued)

SoCalGas' biogas RD&D program can catalyze various stakeholders to help jump start activity in California by closing a number of significant technology gaps. These gaps involve capital and operating cost minimization, performance and reliability improvements, techniques for processing various biomass feedstock, and safety protocols, among others. Examples of current biogas technology gaps include:

- Biomass gasification system cost, performance and reliability;
- Cost-effective systems that convert syngas from biomass gasification into methane;
- Biogas upgrading system performance and reliability;
- Comparative performance and reliability of various biogas upgrading technologies such as pressure swing adsorption, membranes, water scrubbing, amine wash, and cryogenic distillation;
- Performance and reliability of activated carbon beds, "iron sponge," SulfaTreat, and other biogas upgrading system components;
- Biogas system design optimization for efficiency, safety and reliability;
- Demonstration of biogas quality monitoring and control systems and protocols;
- Establishment of digester gas sampling and analysis requirements and protocols. This must cover contaminates ranging from silicon compounds to pharmaceuticals;
- Mass and energy balance data to establish the efficacy of bioenergy recovery by various technologies and systems;
- Biogas interconnection cost, safety and reliability (for example, low-cost laser systems that test for a larger variety of potential contaminants on a continuous flow basis).

In 1990, natural gas buses were nonexistent in Southern California. However, thanks in part to SoCalGas' RD&D program efforts to develop natural gas bus engines and fueling stations, Southern California now leads the nation in natural gas bus usage. Similarly, SoCalGas believes a robust biogas RD&D program can help make high levels of pipeline quality biogas production in Southern California a reality in the not too distant future.