Company: Southern California Gas Company (U 904 G)
Proceeding: 2019 General Rate Case
Application: A.17-10-___
Exhibit: SCG-21

SOCALGAS

DIRECT TESTIMONY OF LISA L. ALEXANDER

(CUSTOMER SERVICES - TECHNOLOGIES, POLICIES & SOLUTIONS)

October 6, 2017

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

317179

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CS - TECHNOLOGIES, POLICIES & SOLUTIONS (In 2016 $)			
Operations & Maintenance	2016 Adjusted-Recorded (000s)	TY 2019 Estimated (000s)	Change (000s)
Total Non-Shared Services	11,410	15,226	3,816
Total Shared Services (Incurred)	3,216	4,008	792
Total	**14,626**	**19,234**	**4,608**

Summary of Requests

Southern California Gas Company (SoCalGas) is requesting $19.234 million for Test Year (TY) 2019 Operations and Maintenance (O&M) costs associated with the Customer Services - Technologies, Policies and Solutions cost categories; an increase of $4.608 million over Base Year (BY) 2016 levels. These activity areas cover a variety of functions and activities to promote the development and implementation of policies, regulations and technologies that optimize the use of natural gas as an environmentally beneficial and cost-effective energy solution, enhance safety and reliability of the natural gas delivery system, support customer adoption and use of low-emission technologies, and support a variety of statewide initiatives and customer needs in related areas. Cost drivers for Customer Services - Technologies, Policies and Solutions include:

- The need to develop and deploy technologies that enhance system safety and reliability; cost effectively meet increasingly stringent environmental requirements, including dramatic reductions in greenhouse gas (GHG) and criteria pollutant emissions; enable increased integration of renewable energy; allow for the continued use of increasingly efficient equipment; facilitate the use of renewable gas in the transportation sector; and, support evolving customer needs.
- Costs associated with long-term planning, tracking of natural gas industry trends, support for statewide initiatives and project analysis.
- The numerous and complex state legislative and regulatory matters relevant to natural gas and renewable gas utilization, including matters related to achieving state environmental goals and addressing customers' needs.

- The number and complexity of municipal, county and regional climate and energy sustainability planning efforts in which SoCalGas will engage to support customers' needs.
- The increased complexity of franchise negotiations with local governments and increased efforts by local governments to impose new and often more stringent and costly operating conditions on SoCalGas, such as trenching and paving requirements.

SOCALGAS DIRECT TESTIMONY OF LISA L. ALEXANDER
(CUSTOMER SERVICES - TECHNOLOGIES, POLICIES & SOLUTIONS)

I. INTRODUCTION

A. Summary of Costs and Activities

My testimony supports the TY 2019 forecasts for O&M costs for both non-shared and shared services for the forecast years 2017, 2018, and 2019, associated with the Customer Services - Technologies, Policies & Solutions area for SoCalGas. There are no capital costs forecast for Customers - Service Technologies, Policies & Solutions. Table LLA-1 summarizes my sponsored costs.

TABLE LLA-1
TY 2019 Summary of Total O&M Costs

CS - TECHNOLOGIES, POLICIES & SOLUTIONS			
Shown in Thousands of 2016 Dollars	**2016 Adjusted Recorded**	**TY 2019 Estimated**	**Change**
Non-Shared			
Research, Development and Demonstration (RD&D)	10,643	14,329	3,686
Policy and Environmental Solutions NSS	767	897	130
Total Non-Shared	**11,410**	**15,226**	**3,816**
Shared			
Policy and Environmental Solutions	2,026	2,508	482
Business Strategy and Development	1,190	1,500	310
Total Shared Services (Incurred)	**3,216**	**4,008**	**792**
Total O&M	**14,626**	**19,234**	**4,608**

1. Organization Overview

Customer Service Technologies, Policies & Solutions comprises a group of functions and activities to promote the development and implementation of technologies and policies that optimize the use of natural gas as an environmentally beneficial and cost-effective energy solution, enhance safety and reliability of the natural gas delivery system, support customer adoption and use of low-emission technologies, and support a variety of statewide initiatives in related areas.

A major focus of Customer Services - Technologies, Policies & Solutions is to advance and support California's environmental quality, and public health and safety goals including those described in witness Bret Lane's Policy testimony (Exhibit SCG-01). These goals include reducing GHG emissions in California to levels 80% below 1990 levels by 2050,[1] attaining Clean Air Act (CAA) standards for Particulate Matter (PM) and smog-causing pollutants, and other environmental and customer policies. To achieve climate and air quality goals, state agencies and legislation have directed focused efforts on a number of key areas. These efforts set the context and scope for my organization's work and include the following:

GHG Reduction Efforts: Senate Bill (SB) 32 Global Warming Solutions Act (2016), SB 350 Clean Energy and Pollution Reduction Act (2015), SB 1383 Short-Lived Climate Pollutants (2016), SB 1371 Natural Gas Leakage Abatement (2014), County and Municipal GHG Reduction Plans;

Air Quality Efforts: Federal CAA, Assembly Bill (AB) 617 Nonvehicular Air Pollution – Criteria Air Pollutants and Toxic Air Contaminants (2017), Air Quality Management District Proceedings (Nitrogen Oxides (NOx) and PM emissions reductions);

Renewable Resource Efforts: Renewable Portfolio Standard, Bioenergy Action Plan, Alternative and Renewable Fuel and Vehicle Technology, California Solar Thermal Initiative;

Energy Policy Efforts: Zero Net Energy (ZNE) efforts, Distributed Generation (DG) and Combined Heat and Power (CHP), California Energy Commission (CEC) Integrated Energy Policy Report (IEPR); and

Reliability and Safety Efforts: Pipeline Safety Requirements, County and Municipal Resilience and Sustainability Planning Efforts.

More detailed summaries of the above legislative, state agency and local government efforts to advance and support environmental quality and public health and safety goals can be found in Appendix A.

2. SoCalGas is Uniquely Positioned to Support State Environmental Goals

SoCalGas is uniquely suited to support state policy goals and balance the interests of our customers. Indeed, natural gas has been one of the critical components enabling the state to

[1] Executive Order (EO) S-3-05, *available at*: https://www.gov.ca.gov/news.php?id=1861. EO-S-3-05 establishes greenhouse gas emission reduction targets, creates the Climate Action Team and directs the Secretary of Cal/EPA to coordinate the efforts to meet these targets with the heads of other state agencies. The EO requires the Secretary to report back to the Governor and Legislature biannually on progress toward meeting the GHG targets, GHG impacts to California, Mitigation and Adaptation Plans.

achieve the interim RPS. Natural gas will play an even more critical role in helping the state achieve its 50% RPS goal by 2030. Renewable Gas (RG) will also be integral to the state reaching its goal of 40% reduction of GHG emissions below 1990 levels by 2030 by reducing fugitive methane emissions from the agricultural and waste sectors, as well as smog-producing pollutants in the transportation sector. Our understanding of operations and state environmental goals enables us to represent customer interests, ensuring that natural gas and Renewable Gas are part of the solution for a diverse, reliable, cost-sensitive energy mix.

As the state moves aggressively to reduce climate change impacts, we also must address aggressive air quality goals unique to our service territory. In fact, SoCalGas' service territory encompasses both the South Coast Air Quality Management District (SCAQMD) and the San Joaquin Valley Air Pollution Control District (SJVAPCD) -- two extreme non-attainment areas under the Clean Air Act with severely poor air quality linked to increased health risks of asthma, developmental delays in children, lung cancer and premature death.

SoCalGas supports climate and air quality goals through Research, Development and Demonstration (RD&D) efforts, and by analyzing and determining how a broad range of legislative and policy issues will affect SoCalGas' customers and operations, and then developing potential policy alternatives to help protect customer interests.

SoCalGas has deep expertise in natural gas policy matters as well as natural gas technologies and their potential advancement. Further, SoCalGas has a unique role in representing the interests of its customers, including disadvantaged communities, on matters that relate to the production, distribution and use of natural gas. SoCalGas supports technology-neutral policies and regulations, and we work to ensure that the most economic and feasible pathways to achieving state goals will be considered by policy makers. This includes policy and regulations that consider the potential uses of the natural gas system to achieve environmental and economic policy goals – helping keep rates down. Without SoCalGas' involvement, policies and regulations developed to meet long-term environmental objectives would risk foregoing cost-effective emission reduction strategies involving the use of natural gas and RG, and the stability of having a diverse, resilient fuel portfolio.

A diversified mix of energy resources, including natural gas and renewable gas, is crucial to achieving the state's policies and energy reliability. Natural gas provides vital, cost-effective baseload energy to manage intermittency issues associated with wind and solar power,

complementing these renewable resources when the sun does not shine and wind does not blow. The natural gas system also is critical to maintaining resiliency in the event of climate change and extreme weather events. Energy portfolio diversity is similarly important for prudent risk management and to support resiliency and security in the energy portfolio, along with corresponding reliable electric service for customers.

As the state continues to plan for the clean energy future, it is important to recognize the crucial role of RG in reaching climate and air quality goals. SoCalGas is helping transform and meet the state's environmental goals by building its RG solution in a cost-effective manner for customers.

Consistent with the state's environmental goals and the context of the various proceedings described above, SoCalGas is looking at natural gas supply like California looks at electric supply. Over the past 30 years, the state has been increasing the use of renewable resources to make the electric supply more renewable and lower in carbon emissions.[2] SoCalGas plans to do the same with gas supply. RG from a variety of sources can displace traditional natural gas – in fact, California's energy and climate change goals require us to do this. As discussed in more detail below, the state's goals require capture of 40% of methane emissions from primarily the state's waste streams.[3] This methane can be put to beneficial use if it is stored in our pipeline system and delivered to customers, who will not need to change their end-use equipment. In doing this, our objective is to take the fossil out of the fuel supply and decarbonize the pipeline.

The continued use of the gas pipeline delivery system to provide another form of renewable energy in addition to renewable electricity provides environmental, reliability, resiliency and economic benefits to all Californians. For example, unlike other renewable resources, RG helps manage intermittency and supports resiliency, because it is available twenty-four hours a day, seven days a week. Since over 80% of California's methane emissions come

[2] California Public Utilities Code (PUC) § 399.11(b) ("Achieving the renewables portfolio standard through the procurement of various electricity products from eligible renewable energy resources is intended to provide unique benefits to California, including all of the following, each of which independently justifies the program: . . . (4) Meeting the state's climate change goals by reducing emissions of GHGs associated with electrical generation.").

[3] Senate Bill (SB) 1383 (Lara, Stats. of 2016).

from agricultural and waste industries,[4] putting organic waste streams to beneficial use in the form of RG is critical to meeting climate change and air quality goals. Increasing the use of RG as a transportation fuel would not only reduce methane emissions from organic waste streams, but also help reduce criteria pollutants, which improves air quality for our customers, by displacing diesel in heavy-duty vehicles.[5] As demand for RG as a transportation fuel increases, it will attract additional supplies to the region, which can then be used to decarbonize natural gas end uses in homes and businesses.

The common theme in my testimony below is SoCalGas' commitment to being a responsible partner in meeting our customer's energy needs and the state's environmental goals. RG is the keystone to realizing this vision.

B. Summary of Costs Related to Fueling Our Future (FOF)

As described in the joint testimony of witnesses Hal Snyder and Randall Clark (Exhibit SCG-03/SDG&E-03), the utilities kicked off the FOF initiative in May 2016, to identify and implement efficient operations improvements. The FOF savings identified in Customer Services - Technologies Policy and Solutions will result from reduced consultant spend that will be achieved through renegotiation of consultant fees. Table LLA-2 provides a summary of the FOF cost efficiencies described in my testimony:

TABLE LLA-2
Summary of FOF Costs

CS - TECHNOLOGIES, POLICIES & SOLUTIONS (In 2016 $)			
FOF O&M	**Estimated 2017 (000s)**	**Estimated 2018 (000s)**	**Estimated 2019 (000s)**
FOF-Ongoing Benefits	-50	-50	-50
Total O&M	**-50**	**-50**	**-50**

[4] "Methane," California Air Resources Board, *available at*: https://www.arb.ca.gov/cc/inventory/background/ch4.htm.

[5] "Short-Lived Climate Pollutant Reduction Strategy" at 61-63, California Air Resources Board, *available at*: https://www.arb.ca.gov/cc/shortlived/meetings/03142017/final_slcp_report.pdf (March 2017).

C. Summary of Aliso-Related Costs

In compliance with D.16-06-054,[6] the testimony of witness Andrew Steinberg (Exhibit SCG-12) describes the process undertaken to ensure the TY 2019 forecasts do not include the additional costs from the Aliso Canyon Storage Facility gas leak incident (Aliso Incident), and demonstrates that the itemized recorded costs are removed from the historical information used by the impacted General Rate Case (GRC) witnesses.

As a result of removing historical costs related to the Aliso Incident from Customer Service Technologies, Policies & Solutions adjusted recorded data, and in tandem with the forecasting method(s) employed and described herein, additional costs of the Aliso Incident response are not included as a component of my TY 2019 funding request. Historical Customer Services - Technologies, Policies & Solutions costs that are related to the Aliso Incident are removed as adjustments in my workpapers (Exhibit SCG-21-WP) and also identified in Table LLA-3 below.

TABLE LLA-3
Summary of Excluded Aliso-Related Costs

CS - TECHNOLOGIES, POLICIES & SOLUTIONS (In 2016 $)			
Workpaper	**2015 Adjusted-Recorded (000s)**	**2016 Adjusted-Recorded (000s)**	**Total (000s)**
2RD000.000, Environmental Strategy	0	-1,127	-1,127
2RD002.000, Policy & Environmental Solutions NSS	-3	-3	-6
Total Non-Shared	**-3**	**-1,130**	**-1,133**
2200-2229.000, Business Strategy and Development	0	-142	-142
2200-2288.000, Environmental Affairs	0	-1	-1
2200-2504.000, Public Policy & Planning	0	-3	-4
Total Shared Services	**0**	**-147**	**-147**
Total O&M	**-3**	**-1,277**	**-1,281**

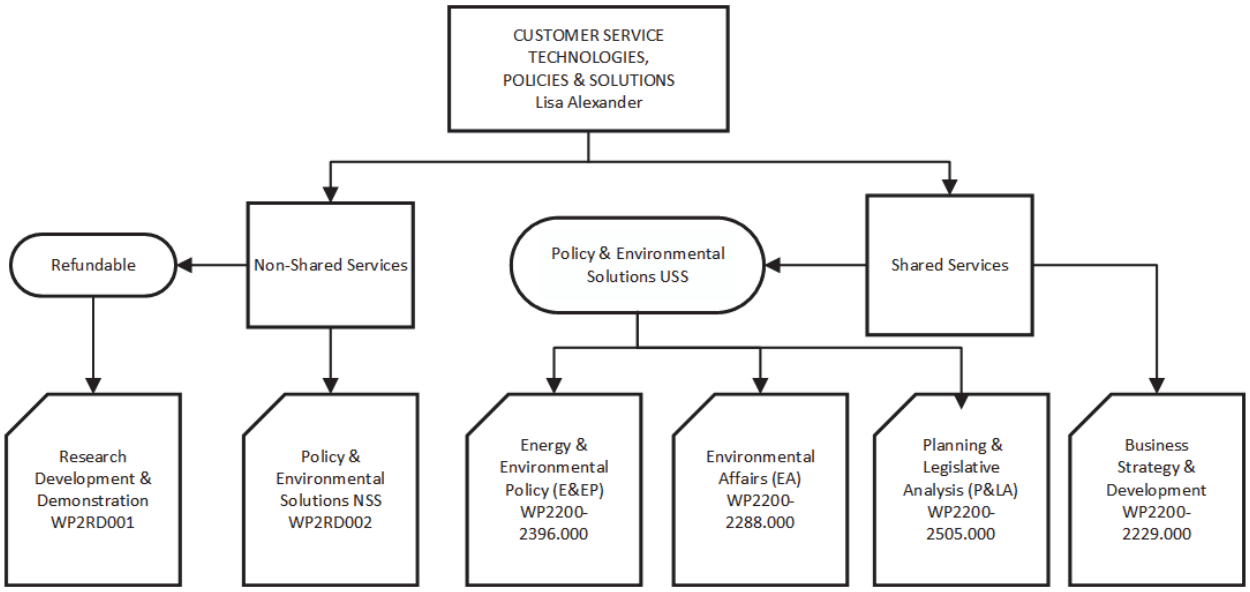
D. Organization of Testimony

My testimony is divided into two sections, non-shared and shared service costs. Within those sections, my testimony addresses three primary activities: RD&D; Policy &

[6] D.16-06-054, mimeo., at 332 (Ordering Paragraph 12) and 324 (Conclusion of Law 75).

Environmental Solutions Non-Shared Services (NSS); and Business Strategy & Development. Policy & Environmental Solutions has several cost centers, including one non-shared cost center and three shared cost centers. The sections and sub-sections are shown in Figure LLA-1 below:

FIGURE LLA-1
Organization of Testimony



In addition to sponsoring my own organization's costs, my testimony also provides the context for forecasted costs towards activities to address short-lived climate pollutants through RG in the testimonies of witness Deanna Haines, Gas Engineering (Exhibit SCG-09) and witness Andrew Cheung, Customer Services - Information (Exhibit SCG-20).

My testimony is organized as follows:

- Introduction
- Safety Culture
- Non-Shared Costs
  - RD&D
  - Policy and Environmental Solutions NSS
- Shared Costs
  - Policy and Environmental Solutions
  - Business Strategy and Development

II. SAFETY CULTURE

SoCalGas' safety culture includes standardizing policies and standards; complying with applicable laws, regulations, and internal policies; building and operating a system that supports the safe and reliable delivery of gas; communicating with stakeholders; and using data and data analysis to help make informed corporate decisions. The Customer Services - Technologies, Policies and Solutions organization engages in the safety culture by supporting policies and technologies that optimize the use of natural gas to reduce the environmental and health impacts of GHG and criteria pollutants, as well as enhancing the safety and reliability of the natural gas delivery system.

More specifically, Customer Services - Technologies, Policies and Solutions supports SoCalGas' safety culture by advancing and deploying technologies that improve the safety and reliability of utility operations in the areas of inspection, monitoring, control and construction, as well as technologies that support emissions reductions, such as advancing combustion science and after treatment. Similarly, the organization analyzes and determines how a broad range of legislative, regulatory and policy issues will affect safety of SoCalGas' customers and operations, then develops policy alternatives to help protect customer interests.

In addition to the external safety focus, the organization also promotes safety amongst our employees. This includes safety messages in staff meetings, regular ergonomics training, building emergency planning and safety training, and participation in other company safety programs.

III. NON-SHARED COSTS

NSS are activities that are performed by a utility solely for its own benefit. Table LLA-4 summarizes the total non-shared O&M forecasts for the listed cost categories.

TABLE LLA-4
Non-Shared O&M Summary of Costs

CS - TECHNOLOGIES, POLICIES & SOLUTIONS (In 2016 $)			
Categories of Management	**2016 Adjusted-Recorded (000s)**	**TY 2019 Estimated (000s)**	**Change (000s)**
A. RD&D	10,643	14,329	3,686
B. Policy and Environmental Solutions NSS	767	897	130
Total Non-Shared Services	**11,410**	**15,226**	**3,816**

A. RD&D Refundable Program

TABLE LLA-5
Summary of RD&D O&M Costs

CS - TECHNOLOGIES, POLICIES & SOLUTIONS			
Shown in Thousands of 2016 Dollars			
Categories of Management	**2016 Adjusted-Recorded**	**TY 2019 Estimated**	**Change**
R-RD&D CS TECHNOLOGY DEVELOPMENT	10,643	14,329	3,686
Total	**10,643**	**14,329**	**3,686**

Note: Totals may include rounding differences.

1. Description of Costs and Underlying Activities

The RD&D program identifies and supports new technologies and research activities that benefit customers through improved reliability and safety, environmental benefits and operational efficiencies. Brief summaries of recent RD&D project results can be found in Appendix D.

Per California Public Utilities Code Section 740.1, RD&D activities are only authorized provided that achieving customer benefits is reasonably probable and the focus is not unnecessarily duplicative of efforts by other research organizations. To meet this standard, SoCalGas' RD&D program management teams routinely collaborate with other research funding sources such as the CEC, Department of Energy (DOE), and air quality districts.

The TY 2019 request of $14.329 million supports the company's goals of reducing emissions, improving performance or reducing cost across the full range of natural gas applications and improving the safety and reliability of utility operations. As in prior GRC cycles, the RD&D program costs will be tracked in a one-way balancing account and all RD&D program funding is refundable. The balancing and amortization mechanism for the Research, Development, and Demonstration Expense Account is described in the testimony of witness Rae Marie Yu (Exhibit SCG-42). SoCalGas is not forecasting any non-refundable RD&D program costs.

TABLE LLA-6
RD&D History and Forecast
In Thousands of 2016 Dollars

	Adjusted-Recorded					Adjusted-Forecast		
Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Labor	1,551	1,293	1,553	2,006	2,119	2,086	2,136	2,136
Non-Labor	6,996	7,032	7,144	11,213	8,524	12,119	9,862	12,193
Total	**8,547**	**8,325**	**8,696**	**13,219**	**10,643**	**14,205**	**11,998**	**14,329**
FTE	13.7	11.3	14.2	19.4	20.6	21.1	21.6	21.6

2. Forecast Method

The forecast method developed for this cost category is the zero-based method. This method is most appropriate because specific RD&D needs and activities evolve through time as technologies progress and new public policies and goals are established. Technology needs or gaps were assessed in each program area based on the current state of technology compared to the performance required to meet safety and reliability enhancements, energy efficiency goals, criteria pollutant, GHG emissions and other cost and performance goals (more detail on the technology needs assessment is provided in Appendix B – "Technology Needs Assessment Summary"). The identified technology needs were combined with prior experience on project cost and co-funding requirements to develop target projects and funding requirements in each program area, including one additional full-time equivalent (FTE) to manage these efforts. The TY 2019 forecast reflects increased RD&D activity in RG production, criteria pollutions reduction, carbon reduction, natural gas transportation, and gas transmission and distribution system safety and reliability.

Alternative forecasting approaches, such as forecasting based on averages or trends, would not be appropriate as they would fail to reflect increased needs for technology development to enhance safety and reliability and to meet emission reduction requirements.

3. Technology Royalties & Revenues

In some instances, SoCalGas receives product royalty rights or equity in companies developing targeted technologies in exchange for funds provided to support technology development and demonstration. These arrangements provide an opportunity for SoCalGas customers to receive a direct financial return should the technology development efforts prove successful.

TABLE LLA-7
Five Year History of RD&D Royalties
In Nominal Dollars

Year	Program Revenues	Customer Portion	Shareholder Portion
2012	1,560,486	1,330,082	230,404
2013	104,394	88,173	16,221
2014	116,659	90,253	26,406
2015	99,689	80,841	18,848
2016	90,882	78,911	11,971
Total	1,972,110	1,668,260	303,850

Note: customer revenue includes recovery of initial program costs and excludes recovery of legal costs and proceeds due to co-investors.

As authorized in D.13-05-010, royalty revenue and net proceeds from the sale of equity holdings are shared 75% to customers and 25% to shareholders[7]. As shown in Table LLA-7 above, customers have received almost $1.7 million in RD&D program revenue over the past five years through royalty and equity provisions in program funding agreements. SoCalGas proposes to continue the sharing mechanism approved in D.13-05-010. The portion of royalties allocated to customers is refunded as part of periodic rate adjustments. The Research Royalties Memorandum sharing mechanism is described in the testimony of witness Rae Marie Yu (Exhibit SCG-42).

4. Proposed RD&D Program Supports Environmental, Health, Safety, and Reliability Policy Goals

SoCalGas' RD&D efforts support the goals and efforts described in the introduction of my testimony. The following describes how RD&D specifically supports each of those areas.

- Pipeline Safety: RD&D support is needed for technologies that enhance the safety of the natural gas system through damage prevention. Technologies include improved pipeline mapping and locating programs, active alert systems to

[7] D.13-05-010 at 636 ("We find merit in TURN's argument that ratepayers should be entitled to more of a share of the net revenues from RD&D ventures. However, SoCalGas should receive a share of the net revenues, i.e., an incentive for going forward with the marketing of such ventures. Accordingly, it is reasonable to adopt a sharing mechanism of 75% to ratepayers and 25% to shareholders for such ventures.").

notify operators of third party digging in proximity to pipelines, and break-away shut off devices to mitigate risk in the case of above-ground equipment damage.

- Natural Gas System Reliability: Consistency of service and gas quality are critical to components of meeting customer needs and expectations. RD&D funding supports development of new technologies to repair pipelines without interrupting service, improve corrosion protection technologies to protect underground pipelines, and monitor gas quality more accurately at lower cost.

- Advanced Leak Detection: SB 1371 specifically directs the Commission to develop and implement a comprehensive natural gas pipeline leak reduction strategy that ensures that companies identify and repair methane leaks. RD&D funding is needed to enhance the ability of methane detection systems to detect and monitor low level methane emissions, improve the sensitivity, and reduce the size and cost of the equipment. New platforms, including stationary, mobile, and aerial, would further deploy sensors more effectively.

- RG Development: Additional RD&D funding is required to support the development of new technologies, such as biomass gasification, power-to-gas, and artificial photosynthesis, that can increase the availability of RG within California.

- Short-Lived Climate Pollutants: RD&D support is required to develop and deploy biomass gasification, power-to-gas, and artificial photosynthesis systems to produce sufficient RG to begin decarbonizing the natural gas system.

- NOx and Particulate Matter (PM) Emissions Reductions: Technology advancement in combustion science and after treatment is critical to meeting emission reduction goals. RD&D funding is required to support the development of lower emissions combustion technology for residential heating and cooking, commercial cooking and food service, industrial boilers and process heat, and transportation.

- GHG Emissions Mitigation: Meeting these targets requires dramatic advances in technology to reduce GHG post combustion products and efficiently prioritize leak repairs. RD&D funding is needed to support research in carbon capture and use (CC&U) and low emissions engine and turbine technology to reduce GHG emissions post combustion. Additional research is also required in the field of pipeline emissions detection and quantification to reduce GHG impacts from the natural gas system.

- Indoor Air Quality (IAQ): The planned RD&D addressing indoor air quality is intended to support the development of new technologies that reduce formaldehyde, NOx, carbon monoxide and volatile organic compounds inside homes and businesses. Uses of unvented appliances in the kitchen (range & oven) are of primary concern.

- Distributed Generation and CHP: The California Air Resources Board (CARB) has set emissions limits for NOx, Carbon Monoxide (CO) and Volatile Organic Compounds (VOCs) for DG technologies. RD&D funding is required to achieve progress in cost reduction, efficiency, and emissions control so that DG equipment can meet these emissions reduction goals cost effectively and provide the intended environmental benefits.

- Low Emission Fuel and Vehicle Technology: California Public Utilities Code Section 740.3 codifies the role of utility programs in facilitating the use of natural gas-fueled low-emission vehicles and supporting these goals.[8] RD&D funding is required to develop and demonstrate heavy duty NZE engines and compressed natural gas (CNG) hybrid technologies for a range of vehicle applications.

- ZNE: Development of efficient natural gas technologies to support local energy production can serve a critical role in meeting this goal, particularly considering the intermittent nature of photovoltaic (PV) generation, the predominant on-site generation technology.

- Renewable Portfolio Standard and Power-to-Gas: Integration and firming of renewables is a growing concern for California, and technologies at the intersection of the natural gas and electricity sectors can help address this need while increasing the utilization of existing natural gas infrastructure. Power-to-gas technologies convert excess renewable power to gaseous fuels (hydrogen and methane) that offer storage functionality like those of compressed air and pumped hydro. The associated conversion technologies (*e.g.*, electrolyzers) can also serve multiple grid functions to support further deployment of intermittent renewable generation resources. RD&D funding is required to expand the potential of power-to-gas technologies.

5. Internal Processes and External Collaboration Ensure Synergistic, Non-duplicative, and Effective RD&D

In order to increase RD&D program effectiveness, enhance the probability of program success, avoid duplication and amplify benefits to customers, SoCalGas RD&D expenditures are highly leveraged through collaboration with other funding sources such as CEC, DOE, and air quality districts.

[8] PUC § 740.3(a) ("The commission, in cooperation with…regulated electrical and gas corporations… shall evaluate and implement policies to promote the development of equipment and infrastructure needed to facilitate the use of electric power and natural gas to fuel low-emission vehicles.").

TABLE LLA-8
RD&D Co-Funding for 2016 Active Projects
In Nominal Dollars

RD&D Program	SoCalGas Funding	Co-Funding	Ratio
Customer End-Use Applications, Clean Generation, Clean Transportation	$ 5,869,195	$ 32,717,156	6.57
Gas Operations	$ 2,237,050	$ 9,018,181	5.03
Low Carbon Resources	$ 5,961,025	$ 3,997,474	1.67
Program Wide Partnership	$ 1,275,350	$ 6,355,700	5.98
Total	**$ 15,342,620**	**$ 52,088,511**	**4.40**

The collaboration partners have robust stakeholder engagement and technology gap assessment processes to ensure that their research programs address specific technology needs not being met through other means and have a high potential for commercial success. These processes augment SoCalGas' own industry, agency, university and industry engagement processes to identify unmet or partially unmet technology development needs that the SoCalGas RD&D program can appropriately help address. The SoCalGas RD&D program, unlike other RD&D entities, plays a unique role in serving its mandates to create SoCalGas customer benefits and advance state and Commission policy goals.

6. Funding Detail

TABLE LLA-9
TY 2019 RD&D Program Funding Forecast
In Thousands of 2016 dollars

Program	Sub-Program		TY 2019 Forecast
Customer End-Use Applications	ZNE for Residential		$ 500
	Appliance & IAQ		$ 450
	Commercial Cooking & Food Services		$ 400
	Solar Thermal Heating & Cooling		$ 350
	Boilers & Process Heating		$ 350
		Subtotal	**$ 2,050**
Clean Generation	DG-CHP-MicroCHP		$ 500
	Engines & Turbines		$ 300
	Fuel Cells		$ 500
	Waste Heat Recovery		$ 300
		Subtotal	**$ 1,600**
Clean Transportation	Compression & Refueling		$ 350
	Fuel Systems & Storage		$ 350
	Near Zero Emissions Engines		$ 600
	Compressed Natural Gas & Hybrid Vehicles		$ 300
	Off Road (Locomotives, Construction, & Marine)		$ 350
		Subtotal	**$ 1,950**
Gas Operations	Environmental & Safety		$ 1,321
	Operations Technology		$ 308
	System Design & Materials		$ 499
	System Inspection & Monitoring		$ 1,321
		Subtotal	**$ 3,449**
Low Carbon Resources	Biomass Gasification		$ 2,200
	Power-to-Gas		$ 1,700
	Artificial Photosynthesis		$ 180
	Carbon Capture & Use		$ 200
	Hydrogen Production from Methane		$ 1,000
		Subtotal	**$ 5,280**
Total			**$ 14,329**

The Customer End-Use Application, Clean Generation, Clean Transportation and Gas Operations groups can further leverage RD&D funds in collaboration with natural gas utilities across the country through memberships in trade groups such as NYSEARCH[9] and Operation

[9] NYSEARCH is a collaborative RD&D organization dedicated to serving its gas utility member companies. Members of NYSEARCH voluntarily participate in projects and programs to target RD&D

Technology Development. The Low Carbon Resources group, however, faces challenges unique to a California utility. Fewer co-funding and collaboration opportunities exist in this research domain, as evident from the low leverage ratio shown in Table LLA-8. As such, additional RD&D funding is required to identify and develop new technologies to decarbonize the natural gas system and meet California's aggressive GHG reduction goals.

The SoCalGas RD&D program authorized by the TY 2016 GRC Decision (D.) 16-06-054, adopted an average annual funding level of $12.282 million over the current GRC cycle with all costs tracked via a one-way balancing account. The RD&D program cost forecast for TY 2019 of $14.329 million is driven by the need to develop and deploy technologies that: (1) enhance system safety and reliability; and (2) cost effectively meet increasingly stringent environmental requirements (including dramatic reductions in GHG and criteria pollutant emissions).

As shown in Table LLA-10, the RD&D cost forecast is a small fraction of the total GRC request, making up 0.61 percent of the requested annual authorized GRC base margin revenues. This level of RD&D funding as a proportion of annual authorized GRC base margin revenues is also consistent with the historical range over the last program cycles. As a point of reference, the SoCalGas RD&D forecast is less than 9% of the $162 million budget allocated to the Electric Program Investment Charge established by the Commission in D.12-05-037 for research and development, technology demonstration and deployment of clean energy technologies in the electric utility sector.[10] Furthermore, a Benefit/Cost analysis (Appendix C) conducted by the Gas Technology Institute showed that every dollar of funding committed in the RD&D program returned 1.4 dollars in value to SoCalGas customers.

areas that directly address their unique challenges and opportunities. *See* NYSEARCH, *available at*: http://www.nysearch.org/.

[10] Phase 2 Decision Establishing Purposes and Governance for Electric Program Investment Charge and Establishing Funding Collections for 2013-2020, D.12-05-037 at 73, Table 2 ("Annual EPIC Funding Collections and Allocation Beginning January 1, 2013").

TABLE LLA-10
RD&D Authorized as a Percentage
of Authorized Base Margin Revenues

Year	Annual Authorized RD&D Expenditures	SoCalGas Annual Authorized Base Margin Revenues	RD&D Expenditures as a Percentage of Revenues
	$000 Nominal		
2008	10,000	1,610,510	0.62%
2009	10,000	1,663,407	0.60%
2010	10,000	1,715,288	0.58%
2011	10,000	1,770,782	0.56%
2012	9,264	1,855,615	0.50%
2013	9,509	1,879,348	0.51%
2014	9,770	1,934,044	0.51%
2015	10,039	1,987,220	0.51%
2016	11,862	1,987,220	0.60%
2017	12,277	2,179,314	0.56%
2018	12,707	2,255,590	0.56%
Average	10,493	1,894,394	0.55%
2019 Forecast	14,329	2,334,536	0.61%

RD&D program costs will be tracked in a one-way balancing account and all RD&D program funding is refundable. Costs incurred and tracked in the RD&D balancing account include direct project expenditures and all project-related management and administration costs. This includes non-labor costs used for the direct execution of RD&D projects by third parties under contract to SoCalGas, as well as labor and non-labor costs used in planning, directing, managing and administering these projects.

The RD&D program supports projects in five main research domains:

a. Customer End-Use Applications RD&D

The objectives of Customer End-Use Applications RD&D are to develop and commercialize technologies that cost-effectively improve the efficiency and reduce the environmental impacts of natural gas end-use applications, and seek to support the development and deployment of technologies that cost effectively meet air emissions and efficiency goals.

The TY 2019 funding request of $2.050 million reflects an increase of $417,000 relative to the prior funding cycle to support increased RD&D activity in the areas of energy efficiency, NOx and GHG emissions, and IAQ.

b. Clean Generation RD&D

SoCalGas' Clean Generation RD&D program focuses on supporting the development and demonstration of high-efficiency, low-emissions distributed generation systems for the commercial, industrial, and residential market segments within the SoCalGas service territory.

The TY 2019 funding request of $1.600 million reflects a decrease of $504,000 relative to the prior funding cycle reflecting the reduced spending on oxy-combustion carbon capture technology as that technology has reached commercial readiness.

The SoCalGas RD&D program has supported and will continue to support development and market introduction of low-emission distributed generation technologies, working with equipment providers developing emissions control technologies, improving total system efficiency, reducing system size, assisting new products in obtaining CARB DG certification, and lowering the cost of CHP and other natural gas distributed generation solutions that meet the unique environmental requirements of Southern California.

c. Clean Transportation RD&D

California's transportation sector, which is supported by one of the nation's largest transportation infrastructures to meet its demand, is subjected to the most stringent emissions standards in the nation. As set forth by the United States Environmental Protection Agency (US EPA), CARB, SCAQMD, and SJVAPCD, emissions standards are being reduced to the lowest levels the industry has seen and across the nation. Companies and entities operating on/off-road vehicles within the boundaries of both the SCAQMD and the SJVAPCD must adhere to the new emissions regulations to improve air quality to protect and propagate a cleaner environment for public health, by a certain time frame.

SoCalGas' Clean Transportation RD&D activities focus on minimizing the environmental impacts related to the use of natural gas as a transportation fuel and on reducing the cost of natural gas transportation. Specific areas of activities including fueling systems, natural gas on-board storage, and ultra-low emission engine development. The primary drivers that affect this program area are efficiency improvement, and emissions and cost reduction.

The TY 2019 funding request of $1.950 million reflects an increase of $271,000 relative to the prior funding cycle to increase RD&D efforts in NOx reduction, to address high-horsepower applications such as rail or marine, and to reduce the cost of vehicle fueling compression and storage infrastructure.

d. Gas Operations RD&D

The strategic goals of Gas Operations RD&D are to develop, demonstrate and deploy innovative technologies that measurably benefit SoCalGas in the areas of public and employee safety, operational and maintenance efficiencies, system reliability, reduced environmental impacts from gas operations, and compliance with regulatory mandates. Specific technology objectives and proposed project areas are described in the testimony of witness Ms. Haines (Exhibit SCG-09).

The TY 2019 funding request of $3.449 million reflects an increase of $184,000 relative to the prior funding cycle in order to support increased RD&D activity in the areas of damage prevention, pipeline inspection and safety, methane emissions detection and quantification technologies.

e. Low Carbon Resources RD&D

SoCalGas' Low Carbon Resources RD&D activities focus on technologies to improve and support biomethane and RG production and use. Specific areas of focus include RG production, carbon capture & use, and hydrogen production from methane. Of the cost drivers previously described, efforts to promote widespread deployment of RG production technologies specifically supports the mandate set forth in SB 1383 to reduce emissions of short-lived climate pollutants including methane, the GHG reduction goals set by SB 32, the decreases in carbon intensity of California's vehicle fuel supply set by Executive Order S-01-07[11], the increased production of renewable power set by the Renewable Portfolio Standard, and the increased production of biofuels and bioenergy outlined in the Bioenergy Action Plan.

[11] EO-S-01-07 establishes the Low Carbon Fuel Standard (LCFS) and the target reduction of carbon intensity of California's transportation fuels by at least 10% by 2020. The EO directs the Secretary of Cal/EPA as coordinator of 2020 target activities and requires the Secretary to report back to the Governor and Legislature biannually on progress toward meeting the 2020 target. *See* Executive Order S-01-07, *available at*: https://www.gov.ca.gov/news.php?id=5172.

While biogas production via landfill degradation and anaerobic digestion is well understood, RG, in the form of hydrogen or methane, can also be produced via several new, pre-commercial pathways. The Low Carbon Resources RD&D team is investigating producing RG from biomass and other waste streams through thermochemical conversion processes, from SB 375 renewable electricity through a concept known as power-to-gas, and directly from sunlight via artificial photosynthesis technologies. Once in the form of methane or hydrogen, renewable energy can be readily transported, stored, and distributed to its highest economic value through our nearly ubiquitous natural gas system. This is a growing area of activity in Europe and the DOE has initiated related analysis and development activities in which SoCalGas is collaborating.

The TY 2019 funding request of $5.280 million reflects an increase of $2.099 million relative to the prior funding cycle in order to support increased research, development, and demonstration activity in the areas of near-commercial technologies for converting biomass or excess renewable power to RG. Increased investment is required to scale up demonstrations of near-commercial technologies and to expand the study of system wide impacts on the gas and electric grids resulting from the deployment RG production projects and power-to-gas technologies.

B. Policy & Environmental Solutions NSS

Table LLA-11
Policy & Environmental Solutions NSS
(Thousands 2016 dollars)

	Adjusted-Recorded					Adjusted-Forecast			Change
Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2016-2019**
Labor	0	33	228	316	633	633	748	748	115
Non-Labor	0	24	50	134	134	134	149	149	15
Total	**0**	**58**	**278**	**449**	**767**	**767**	**897**	**897**	**130**
FTE	0.0	0.2	1.9	2.7	5.0	5.0	6.0	6.0	1.0

Table LLA-11 above presents the non-shared service costs for the Policy & Environmental Solutions function. Both non-shared service costs and shared services costs are incurred within this function. Only the non-shared service costs are presented in this section of the exhibit.

1. Description of Costs and Underlying Activities

The Policy & Environmental Solutions NSS group's function is to monitor, analyze and determine how the broad range of policy and legislative issues defined in the Introduction of my testimony will affect SoCalGas' customers and operations. The group also develops potential policy alternatives to help protect the interests of natural gas customers with respect to safety, reliability and affordability. The group leads analysis, strategy development and implementation on local sustainability planning and on other local and regional planning initiatives.

By educating local and regional governments on the needs of customers and environmental benefits and cost-effectiveness of natural gas and RG in meeting those needs, these entities can incorporate natural gas energy efficiency measures, clean transportation, distributed energy resources and RG into sustainability planning efforts to help cost-effectively achieve emission reduction goals. And by educating local and regional governments on how natural gas and RG support customers' needs and diversify the energy resource mix, these entities can develop more robust resiliency plans with an increased likelihood of ensuring reliability. Absent SoCalGas' involvement in these planning activities, communities may fall short of attaining state emission reduction goals and could be more vulnerable to energy disruptions.

The group is further responsible for developing franchise strategies and leading timely negotiations of franchise agreements with municipalities within SoCalGas' service territory to help secure cost-effective outcomes for both customers and the company. In addition, the group engages in negotiations with local governments to protect franchise rights necessary to deliver energy to our customers. When local governments propose significant permit fees or attempt to impose conditions that potentially increase operating costs and/or create a precedent that may adversely impact customers, the group must increasingly engage with local governments to help mitigate these costs, thereby securing cost-effective outcomes. In the BY 2016, 5 FTEs were devoted to monitoring, analyzing and determining the impact of policy and legislative issues.

2. Forecast Method

A base year forecast method is used for this cost category with incremental activity beyond the base year level. This method is most appropriate because trends, multi-year averages or other methods would not reflect the fact that Policy and Environmental Solutions is a newly formed organization that consolidates several pre-existing functions but also adds new functions

not included in the predecessor organizations. They would also not reflect the impact of new regulations and policy matters that will need to be addressed during the forecast period that were not in effect during the historical period.

3. Cost Drivers

I am requesting an increase of $130,000 over adjusted recorded costs for an additional FTE to support local and regional planning activities, franchise strategy development and negotiations, and protection of franchise rights.

The primary cost drivers for the group are the number and complexity of policy matters relevant to natural gas utilization. Similarly, the level of engagement on franchise and fees matters drives costs for the group. The complexity of these activities has increased over the past few years and this will continue through the forecast period. The Company's activities in these areas serve to protect the interests of customers by providing specific input, developed through internal and external analysis, on policy and legislative approaches.

In TY 2019 and beyond, due to the increasing focus on climate change, we expect the number of bills introduced and policies developed that pertain to natural gas, RG and energy to increase. For example, in the past three years, there have been seven bills related to major climate initiatives, including two bills that are specifically related to the regulation of methane emissions. These bills will have a major impact on the company and our customers. There have also been two major air pollution bills.

Without SoCalGas' involvement, policies that negatively impact natural gas customers would be more likely to be implemented without adequate information on their consequences and potential alternatives.

SoCalGas anticipates expending significant resources engaging with local governments on climate, energy and sustainability planning issues. According to data compiled by the Governor's Office of Planning and Research, there are approximately 50 jurisdictions in the SoCalGas service territory that are in the process of developing climate change policies and plans.[12] Other types of policies and plans underway include vulnerability assessments, GHG emissions inventories, GHG reduction plans, energy action plans, adaptation or resilience plans,

[12] "California Jurisdictions Addressing Climate Change", Governor's Office of Planning and Research, *available at*: http://www.opr.ca.gov/docs/California_Jurisdictions_Addressing_Climate_Change_PDF.pdf

sustainability plans and local coastal programs. Additionally, SB 375[13] requires metropolitan planning organizations to meet GHG emission reduction targets through integrated transportation, land use and housing planning. Seven metropolitan planning organizations within SoCalGas' service territory are expected to update their Sustainable Community Strategies during the rate case period to meet new SB 375 GHG emission reduction targets.

During the rate case period, the workgroup will develop and implement franchise strategies and lead franchise negotiations with the cities of La Canada-Flintridge, Long Beach, Los Angeles, Pasadena, and Redondo Beach, as well as Riverside and Los Angeles counties. Negotiations during the rate case period with larger cities, such as Los Angeles, Long Beach and Pasadena, as well as with large counties, such as Los Angeles and Riverside, are more complex and time-intensive. Local governments are also drawing out franchise negotiations, hoping to secure concessions from SoCalGas.

Local governments are increasingly seeking new and often more stringent and costly operating conditions, such as engineered traffic control plans, additional paving requirements, increasing requests to remove instead of abandon pipelines, increasing requests to eliminate or minimize above-ground facilities, and sharply restricting working hours. Examples of such actions by local governments in 2017, include new trenching and paving standards enacted by the City of Los Angeles[14] and a proposed[15] ordinance by the County of Riverside placing additional requirements on work in the right-of-way.

As a result of increased policy, legislative, planning, and franchise and fees activities over the rate case period, we forecast the addition of one FTE and related non-labor expense to the work group.

IV. SHARED COSTS

A. Introduction

Table LLA-12 summarizes the total shared O&M forecasts for the listed shared-services elements of my testimony. I am sponsoring the forecasts on a total incurred basis, as well as the

[13] SB 375 (Steinberg, Stats. of 2008) is the Sustainable Communities and Climate Protection Act of 2008.

[14] LA City Trenching Standards, Standard Plan No. S-477, *available at*: http://eng2.lacity.org/techdocs/stdplans/s-400/S-477-0%20June%2030%202017.pdf (June 30, 2017).

[15] Riverside, Cal., Ordinance No. 499.14 (2017).

shared services allocation percentages related to those costs. Those percentages are presented in my shared services workpapers (Exhibit SCG-21-WP). The dollar amounts allocated to affiliates are presented in our Shared Services and Shared Assets Billing Policies testimony. (*See* the testimony of witness James Vanderhye (Exhibit SCG-34.)

Table LLA-12 summarizes the total shared O&M forecasts for the listed cost categories.

TABLE LLA-12
Shared O&M Summary of Costs

CS - TECHNOLOGIES, POLICIES & SOLUTIONS (In 2016 $)			
(In 2016 $) Incurred Costs (100% Level)			
Categories of Management	**2016 Adjusted-Recorded (000s)**	**TY 2019 Estimated (000s)**	**Change (000s)**
A. Policy and Environmental Solutions	2,026	2,508	482
B. Business Strategy and Development	1,190	1,500	310
Total Shared Services (Incurred)	**3,216**	**4,008**	**792**

B. Policy & Environmental Solutions

TABLE LLA-13
Policy & Environmental Solutions
In Thousands of 2016 Dollars – Incurred Costs

	Adjusted-Recorded					**Adjusted-Forecast**			**Change**
Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2016-2019**
Labor	711	704	1,143	1,061	1,286	1,041	1,335	1,335	49
Non-Labor	1,256	1,426	1,452	1,124	740	793	958	1,173	433
Total	**1,967**	**2,130**	**2,595**	**2,185**	**2,026**	**1,834**	**2,293**	**2,508**	**482**
FTE	6.4	6.4	9.7	8.9	10.6	9.2	11.8	11.8	1.2

Note: Totals may include rounding differences

1. Description of Costs and Underlying Activities

Table LLA-13 summarizes the costs incurred and forecast for the Policy & Environmental Solutions (P&ES) group, which was formed in 2013 and expanded its role in 2015, as state environmental initiatives have expanded. Policy & Environmental Solutions consists of the Energy & Environmental Policy (E&EP), Environmental Affairs (EA) team, and the Planning & Legislative Analysis (P&LA) team. These groups are collectively responsible for

policy analysis, engagement, outreach and customer support related to existing and proposed state and federal policies, including laws and regulations related to natural gas and RG utilization and environmental policy, specifically focused on air quality and climate change policy. To represent the interests of SoCalGas and SDG&E's customers, the group incurs labor and non-labor costs related to policy analysis and engagement with local and state regulatory organizations as they develop rules and regulations on air quality, climate change and energy utilization. The state and local jurisdictions have numerous proceedings and hearings that could impact the utilities' operations and customers. Understanding the implications of these proceedings and providing analysis and evidence to support the efficient use of natural gas in support of state policy, benefits customers and state policy makers. Non-labor costs incurred by this group include employee-related costs and costs for external expert support in the areas of economy-wide impacts on economic and air emissions of proposed policies, laws and regulations, and company and customer compliance impacts.

The P&ES group provides policy guidance and analysis on proposed regulation and legislation to the Regulatory Affairs and State Government Affairs groups, which are responsible for management of proceedings before the Commission, state agencies and the legislature. P&ES has specific expertise with respect to air quality and climate change, and working across agencies (including the local air districts, CARB, CEC, California Department of Food and Agriculture (CDFA), CalRecycle and US EPA Region 9) to ensure that environmental policies are promulgated in a reasoned and consistent manner.

SoCalGas forecasts a required funding level of $2.508 million for TY 2019. This request represents an increase of $0.482 million compared to BY 2016 incurred costs. Staffing is increased by 1.2 FTEs, from 10.6 FTEs in BY 2016 to 11.8 FTEs in TY 2019. The staffing increases reflected in the forecast are necessary to respond to a substantial increase in energy and environmental legislative, policy and regulatory activities, as well as an increase in customer need for compliance assistance.

TABLE LLA-14
TY 2019 Incremental Funding Summary
In Thousands of 2016 Dollars – Incurred Costs

Program Area	Recorded 2016			TY 2019			Change
	Labor	Non-Labor	FTE	Labor	Non-Labor	FTE	2016 - 2019
Energy & Environmental Policy	603	700	4.8	542	1,098	5.0	337
Environmental Affairs	478	35	3.8	588	60	4.8	135
Planning & Legislative Analysis	205	5	2.0	205	15	2.0	10
Total P&ES	**1,286**	**740**	**10.6**	**1,335**	**1,173**	**11.8**	**482**

Note: Totals may include rounding differences.

2. Supporting State Policy Goals and Protecting Customers

The P&ES group evaluates the impact of state and federal policies on the use of energy by customers. The two driving environmental issues in our region are air quality and climate change. Local air districts and governments, as well as state agencies, are proposing numerous rules to improve air quality and reduce GHG emissions. P&ES looks at how the natural gas and RG (methane from organic sources and other carbon neutral resources) can provide cost-effective reductions in emissions. P&ES is able to look across the multiple agencies and emissions reduction strategies to identify opportunities for advances in natural gas technologies and low carbon fuels to reduce emissions, while minimizing the impact on customers. Some large customers have environmental policy teams to address issues impacting their operations at these agencies. However, the majority of the utilities' residential and commercial customers would not be represented in these proceedings and planning efforts without the engagement of the P&ES group. Policies supporting the efficient use of natural gas and RG in ways that advance state and Commission energy and environmental policy goals benefit customers through cleaner air, lower rates, and reduced direct compliance costs for customers.

3. Forecast Method

Energy & Environmental Policy and Environmental Affairs

A five-year average was selected for both E&EP and EA to reflect the increased level of activity at the targeted agencies over the past few years. Due to legislation on GHG reductions and natural gas infrastructure, there has been an increase in the regulatory proceedings by both CARB and CEC, as well as joint agency engagement with CDFA, CalRecycle and the

Commission. To manage this additional activity, we have dedicated additional resources to this area. The five-year average with an adjustment for personnel changes reflects the best representation of the on-going needs for this function.

Planning & Legislative Analysis

A BY forecast method is used for P&LA with incremental activity beyond the base year activity level. This method is most appropriate because trends, multi-year averages or other methods would not reflect the fact that P&LA is a newly formed organization that consolidates several pre-existing functions but also adds new functions not included in the predecessor organizations. Other methodologies would also not reflect the impact of new regulations and policy matters that will need to be addressed during the forecast period that were not in effect during the historical period.

4. Cost Drivers

The primary cost drivers for the P&ES group are the number and complexity of policy, regulatory, and legislative matters relevant to natural gas and RG. As the state embarks on accelerating reductions in GHG emissions and addressing short-lived climate pollutants, as well as the critical imperative to reduce criteria pollutants, the volume and complexity of proceedings and rule-makings continues to grow. With the recent adoption of AB 617,[16] CARB and the local air districts are required to develop and implement 13 new programs, plans, systems, strategies, rules and activities, one of which requires review and evaluation of all existing air district rules and regulations. Just the two largest air districts, South Coast and San Joaquin Valley, have over 440 existing rules and regulations, with additional rules under development. In addition, the US EPA adopted a new ozone standard in 2015, which will bring additional air districts into non-compliance. The current administration has delayed the designation of non-attainment regions by one year to 2018. But, multiple air districts within our service territories will need to develop plans in the 2018-2020 time period. All of these activities have seen dramatic increases over the past few years and are expected to continue through the forecast period. Our activities serve to protect the interests of customers by providing specific input, developed through internal and external analysis, on policy, regulatory and legislative approaches. Our role is to educate

[16] Assembly Bill (AB) 617 (Garcia, Stats. of 2017) ("Nonvehicular Air Pollution Criteria Air Pollutants and Toxic Air Contaminants Act of 2017"). *See* Appendix A for additional information.

policymakers on gas utility operations and the use of natural gas and renewable gas by our customers and to support the agencies in achieving state environmental goals in the most cost-effective manner. CARB, CEC and all air districts benefit from our participation, including attendance at meetings and workshops, evaluation of technologies and monitoring systems, preparation of comments, and education of customers.

Work drivers and resourcing levels are discussed below for the three activity areas of the group: (1) State energy and environmental policy and regulation; (2) local air district liaison and customer support; and (3) legislative and public policy matters. Work drivers related to external expert support for these areas is discussed separately at the end of this section of testimony.

a. State Environmental Agency Regulatory Support

The E&EP staff support the development and implementation of policies affecting natural gas and RG delivery and utilization. The team is responsible for regulatory proceedings at CARB and CEC on natural gas utilization, environmental policy and regulation, such as GHG regulation and air quality, and energy policy and regulation, such as the CEC IEPR. In addition, the team supports Joint Agency proceedings at CDFA and CalRecycle on RG and gas quality.

In BY 2016, 4.8 FTEs[17] were devoted to work on energy and environmental policy matters facing our customers. CARB staff completed principal work on several major planning initiatives in the 2015-16 timeframe – Mobile Source Strategy, State Implementation Plan (SIP), Low Carbon Fuel Standard (LCFS) update, Sustainable Freight Plan and 2030 Scoping Plan Update.[18] E&EP was engaged in all of these efforts to ensure natural gas customers are considered in the development of these plans. In late 2017-18, CARB will begin ramping up on programs to implement AB 617, and further development of rules associated with the SIP. These efforts provide an opportunity for CARB to develop rules that will significantly improve air quality in our region. It is important for E&EP staff to engage with staff in their workshops and technical meetings to represent our customers' interests. In addition, CARB will be developing rules to support policies adopted in 2017 on SB 1383 - Short-lived Climate Pollutants (SLCP). SLCP is a vital part of achieving California's 2030 GHG targets, and delivery of renewable gas through the utility pipeline, including for use as a transportation fuel to reduce

[17] The group had 4.8 FTEs reflecting partial year employment for two team members.

[18] Several of these Plans were adopted or are pending approval in 2017.

criteria pollutant emissions from the transportation sector, is an important part of CARB's SLCP strategy.[19] Most of these activities will continue and increase through the forecast period. As a result, the forecast increase of .2 FTE as compared to BY 2016 is necessary to support the expanding activities at CARB and CEC on renewable gas and air quality. As described in the introduction of my testimony, these include the mid-term and long-term contributions of natural gas in supporting GHG/SLCP reduction in the energy and transportation sectors, impacts on gas distribution customers of proposed policies and regulations pertaining to air quality and climate change, and the contributions of RG in our energy and transportation future. Specific matters that will need to be addressed in the TY 2019 timeframe and beyond include:

- CARB SLCP Reduction Strategy: CARB's regulation addressing methane, black carbon, and fluorinated gases was adopted in March 2017, and SoCalGas will be working on implementation of the Strategy as well as on other aspects of SB 1383 implementation focused on the development of RG markets and infrastructure in the next several years.
- CARB Scoping Plan Update: California law requires CARB to periodically update its plan to achieve GHG reductions. The next update will be conducted during the 2019-2021 period. As we get closer to the 2030 target date, there will be an acceleration of programs to ensure California is on track to meet the state-mandated GHG emissions goals.
- CARB SIP Strategy and Mobile Source Strategy: CARB is responsible for developing a statewide plan to demonstrate attainment of federal National Ambient Air Quality Standards (NAAQS), including ozone and fine PM. The local air districts will have new plans due in 2019 and 2020 to address ozone and PM, which will require engagement and planning by CARB, as well. In development of the SIP, CARB conducts workshops and public meetings to better understand technology options and to obtain public comment on viable strategies.

[19] Nearly one-third of the emissions reductions identified in the 2017 Climate Change Scoping Plan Update come from the SLCP. The 2017 Climate Change Scoping Plan Update at 41, Figure II-2 (Jan. 20, 2017).

- CEC IEPR: The CEC updates its IEPR every year. The scope of issues addressed in the IEPR relevant to natural gas and RG has increased in the past few years. This trend is likely to continue through the next GRC period. For example, the 2017 IEPR will include a recommendation on the development and use of RG. In addition, the 2017 IEPR had 37 scheduled workshops. Many of these workshops could have impacts on the natural gas demand forecast and policies affecting natural gas customers. SoCalGas was asked by CEC staff to make presentations at several IEPR workshops, focusing on energy efficiency, energy reliability, integration of the electric system and RG. In addition to participating in and attending workshops, SoCalGas has submitted multiple comment letters on a variety of topics, including Energy Efficiency, RG, and Power-to-Gas. These letters provide input on how policies could impact our customers or provide technical information to help the CEC develop their IEPR report.
- CEC AB 1257 Natural Gas Act Report:[20] The CEC is required to do a comprehensive review of issues impacting natural gas utilization. They are required to conduct a series of workshops and issue an update to the legislature every five years on a broad set of issues including environmental and economic benefits of natural gas, infrastructure utilization, and RG. The next report will be due in 2020.

b. Air Agency Liaison and Customer Support

The Environmental Affairs team is responsible for all regulatory proceedings originating from the nine local air districts in our service territory, and supporting our customers' compliance needs.

New and increasingly complex air quality regulations continue to be developed and introduced as both the SCAQMD and the SJVAPCD are two of the most heavily impacted air districts in the country. In order to demonstrate compliance with increasingly stringent Federal

[20] AB 1257 (Bocanegra, Stats. of 2013). The Natural Gas Act tasks the CEC with assembling a report that "identifies strategies to maximize the benefits obtained from natural gas as an energy source" in California. The CEC must submit an updated report to the Legislature every five years.

and State Clean Air Act Standards for ground level ozone and fine particulate matter, CARB and the air districts are under a continued obligation to evaluate and revise air district rules and regulations. The company actively participates in CARB and air district activities, including attendance at meetings and workshops, evaluation of technologies and monitoring systems, preparation of comments, and education of customers.

EA staff works with these 10 local air districts[21] to contribute expertise, address operational impacts on SoCalGas and SDG&E, and identify the most cost-effective paths for achieving air quality standards. Additionally, EA provides education and support to large non-residential customers who must comply with increasingly complex air quality rules and regulations.

In BY 2016, 3.8 FTEs supported this area and participated in 41 air agency regulatory proceedings and responded to 76 requests for customer assistance. As discussed below, we expect this volume of regulatory activity to increase significantly along with corresponding demands for customer support. This leads to a forecast of 4.8 FTEs through the TY 2019.

The development of new regulations at the air districts is driven by Air Quality Management Plan (AQMP) development and implementation. Local air districts must develop periodic AQMPs that identify control strategies and regulatory pathways to demonstrate attainment of the federal NAAQS. In March 2017, the SCAQMD adopted the 2016 AQMP, which requires a 45 percent reduction in NOx emissions by 2023, and a 55 percent reduction in NOx by 2031, in order to attain federal ozone standards.[22] These drastic emission reductions will require an approximate $1 billion per year investment in clean air infrastructure and technology, and will result in an overhaul of stationary source emissions controls, including natural gas end uses, as well as significant investment in mobile source technologies.[23] Environmental Affairs staff worked closely with SCAQMD staff, other stakeholders, and

[21] There are nine air districts in SoCalGas' service territory and one air district in SDG&E's service territory. Plus, SDG&E's Moreno Compressor Station is under SCAQMD jurisdiction.

[22] *See* 2016 Air Quality Management Plan at 10 et seq., SCAQMD, *available at*: http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2016-air-quality-management-plan/final-2016-aqmp/final2016aqmp.pdf?sfvrsn=15.

[23] *Id*. at ES-9.

customers during the development of the AQMP to ensure fuel and technology neutral policies were incorporated.

While AQMP development required a significant expenditure of resources, we project that implementation of the rulemakings resulting from AQMP strategies will require an even greater investment of resources. In developing the AQMP, District Staff held regular working group meetings and developed whitepapers on several topics to inform their policy development. District staff relied on input from stakeholders and noted the contribution of SoCalGas as energy experts on several occasions. EA staff was able to bring customer groups together to meet with District staff to facilitate a better understanding of how new regulations could impact customers. For example, EA and CS staff facilitated a meeting with the commercial cooking sector so that agency staff could better understand operational considerations and develop a plan to better quantify emissions from commercial cooking equipment. This opportunity to educate agency staff on customer operations is a key example of the valuable support we provide to our customers.

The AQMP contemplates at least fifteen working groups[24] to begin to develop rulemaking strategies, which will commence in 2017 and continue through 2020. These working groups will focus on low emissions technology solutions that will impact natural gas end uses including, space and water heating and commercial cooking equipment, as well as energy efficiency measures, and a suite of transportation solutions. Additionally, as directed by the Governing Board, the SCAQMD has begun to outline the regulatory mechanism for sun-setting the Regional Clean Air Incentives Market (RECLAIM)[25] program for large stationary sources by 2025. Transitioning RECLAIM facilities to command and control regulation will require extensive customer support and outreach. As staff moves into rule development, it will be

[24] The working groups will typically meet monthly. In addition, EA will facilitate informational meetings between SoCalGas subject matter experts and District staff to discuss the status of technology development and to help inform staff about our customers' use of natural gas. As rules are developed, we will also provide informational briefings for our customers to help them understand how they can comply with new rules.

[25] The Regional Clean Air Incentives Market (RECLAIM) program was established in 1994 by SCAQMD to reduce NOx emissions from large stationary sources. The program was designed to provide businesses with flexibility and financial incentives to reduce their emissions. There are approximately 275 NOx RECLAIM facilities, including SoCalGas and SDG&E compression facilities and a variety of commercial and industrial customers from food processors to metal producers to electric generators.

critical for EA to participate in these working group meetings to ensure the District understands how these rules would impact our customers and gas utility operations and to identify strategies to mitigate the impacts.

SJVAPCD is also in the process of developing an AQMP to demonstrate attainment for PM2.5 standards, which will be submitted to CARB in 2018. EA staff is working with the District to develop fuel neutral and cost-effective methods of emissions controls. Activity levels in the San Joaquin Valley will continue to increase through the development and implementation of the AQMP.

Planning & Legislative Analysis

The P&LA group supports legislative and public policy matters. In BY 2016, two FTEs were devoted to monitoring, analyzing and determining how a broad range of legislative issues will affect customers and operations. These issues include RG procurement, methane capture, long-term energy planning, distributed generation, pipeline safety, natural gas storage, dig alert, natural gas as a transportation fuel, climate change, and sustainability.

In the absence of the employees' involvement, laws and policies that negatively impact natural gas customers would be more likely to be signed into law or implemented without adequate information on the consequences of the laws and potential alternatives. For example, in the past year, there has been greater scrutiny and concern about the safety of natural gas storage fields. There have been several bills and regulations aimed at increasing the safety of storage fields and their operation. The bills were worded very broadly, but the intention was to increase safety at each field. Some of the proposed amendments would not have increased safety and were not based on science. The group has worked with state and local government officials to make sure the bills did not impact regular storage operations but did increase the safety of the storage fields. Absent SoCalGas' interactions, these amendments and proposed regulations would have limited our ability to provide reliable service during high demand periods and could have actually decreased the safety at the fields. In TY 2019 and beyond, due to the increasing focus on renewables, the environment, and safety of natural gas infrastructure, we expect the number of bills introduced and policies developed that pertain to natural gas, RG and energy to increase. In addition to five bills related to clean transportation, seven bills related to GHGs and eight bills related to safe operations, the legislature is presently focused on battery storage, yet is not considering alternative lower cost gas technologies. With the extension of cap-and-trade, the

passing of SB 32 in 2016, and a potential new Renewable Portfolio Standard bill in 2017, there will be an extraordinary emphasis on energy legislation and policy in the coming years.

External Expert Support and Non-labor expense

Due to the complexity, ambitious scope and sheer number of plans, policies, and proceedings that affect natural gas customers, we require external support in order to contribute information that will advance the thinking and broaden the perspective of local, state and federal policymakers as they consider how to meet California's ambitious environmental goals and craft new proposed federal climate change-related regulations and policies. SoCalGas' objective is to provide information to relevant state and federal proceedings about natural gas technologies and best practices with respect to controlling methane emissions from natural gas facilities that will help meet environmental goals in the most efficient and cost-effective manner.

In BY 2016, the P&ES group incurred $0.740 million in non-labor expense. Approximately $0.650 million was for external services to: (1) provide expert analysis on economic and environmental impacts of policy and regulatory initiatives; (2) assess the potential long-term role of natural gas in meeting California's GHG and air quality goals;[26] and (3) sponsorship of energy and environmental policy forums.

In TY 2019, non-labor costs for the shared services PE&S group are forecast to be $1.173 million or $0.432 million more than BY 2016. The driver for the increase in external expert support is the growing number of proceedings at the state and federal level related to energy policy, GHG, and air quality; and agency requests for utility participation as energy experts at workshops organized as part of a rule or policy development process.

We have used external expert support to better understand how rules can impact our customers and to develop alternative approaches that can mitigate the impact of policies on customers. This work has included studies on the long-term role for natural gas and the emissions reduction opportunities for different natural gas technologies. The SCAQMD referenced several of these studies in the whitepapers it used to establish policies for the 2016 AQMP. SoCalGas is able to bring internal and external experts and customers together to provide valuable insight to the agencies as they develop Plans to meet the challenging air quality

[26] "Using Low Carbon Gas to Help Meet California's 2050 GHG Reduction Goal" prepared by E3; "Pathways to Near-Zero Emissions," a report prepared by Gladstein, Neandross & Associates; E3 Study to Assess the "Costs and Benefits of Replacing Diesel School Buses with Compressed Natural Gas School Buses."

and climate change emissions reduction targets set by the state. In addition, SoCalGas has partnered with industry groups to educate agency staff on critical technologies and attributes of natural gas and RG.

As the emissions attainment dates grow closer, the agencies will continue to look to stakeholders to help them identify the most economic and beneficial solutions to meet state policy objectives. With the passage of AB 617, we anticipate a greater focus on community air quality monitoring and planning that will require more innovative solutions to meet our air quality challenges. SoCalGas will need to continue to identify strategies to reduce emissions from natural gas equipment and educate agency staff and customers about the opportunities for using more efficient and lower emission natural gas equipment fueled by RG.

Cost Allocation (Shared Service)

Certain activities in the P&ES group benefit gas operations at both SoCalGas and SDG&E. Costs are allocated based on activity analysis or natural gas revenues as a proxy for the benefit to each utility depending on the work group. Only the shared services total incurred costs and functions are presented in this section of the exhibit. The other costs and functions performed by the P&ES function are presented in the non-shared services section of this exhibit. The allocation methodology for each cost center can be found in my workpapers (Exhibit SCG-21-WP).

C. Business Strategy & Development

TABLE LLA-15
Business Strategy & Development
In Thousands of 2016 Dollars – Incurred Costs

	Adjusted-Recorded					Adjusted-Forecast			Change
Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2016-2019**
Labor	659	717	696	758	580	782	807	807	227
Non-Labor	668	555	699	882	610	698	693	693	83
Total	**1,326**	**1,273**	**1,394**	**1,640**	**1,190**	**1,480**	**1,500**	**1,500**	**310**
FTE	5.2	5.8	5.3	6.1	4.4	6.2	6.4	6.4	2.0

Note: Totals may include rounding differences

1. Description of Costs and Underlying Activities

Table LLA-15 summarizes the costs incurred and forecast for the Business Strategy and Development organization. The Business Strategy and Development organization incurs labor and non-labor costs associated with long-term planning, tracking of natural gas industry trends, and project analysis. The group further provides analytical and execution support for initiatives in six strategic priority areas: maintaining system safety and integrity; enhancing system reliability; enabling diverse customer service capabilities and efficiencies; focus on reasonable rates and continuous improvement; workforce investment; and leading clean energy solutions toward a sustainable decarbonized future. The activities of the Business Strategy and Development group assist teams in various divisions in pursuing these priorities and create customer benefit by improving the effectiveness of these efforts. These efforts provide guidance and direction to various divisions to ensure strategic decisions are made in support of customer needs and interests and to guarantee that the utilities efficiently execute on obligations to customers.

To ensure that capital is optimally deployed to benefit our customers, the organization collects and analyzes information on external trends, assists with financial and technical analysis related to major capital projects, supports the long-term capital planning process and develops and maintains analytical and collaboration tools. The cost elements include labor and associated employee costs as well as expenses related to third party information and consulting services.

2. Forecast Method

The 5-year average best reflects activity levels necessary to support the requirements in this functional area inclusive of incremental resource requirements. The incremental resource requirement on labor is delayed backfill of a staff member who left the company in 2016. Non-labor stays flat throughout the forecast period and supports employee costs, funding for company-wide information services, and consulting support for strategic programs.

3. Cost Drivers

SoCalGas requests a funding level for Business Strategy and Development of $1.5 million per year during the proposed GRC cycle. This request represents an increase of $0.310 million compared to BY recorded spend. This increase is due to a combination of returning to routine operations by backfilling a staff position that was left vacant in 2016, and to providing increased support for development and implementation of company-wide optimization and strategic

initiatives. These increased research, analysis, and development activities are in response to the accelerated pace of innovation in business models and technology, and new policies and regulations. This fast-changing environment is primarily driven by the industry-wide transformation to a modernized, decentralized, and decarbonized energy infrastructure.

Costs in the Business Strategy and Development group are driven by a number of factors including:

- The depth and breadth of the research, analysis, and financial modeling required to prepare the annual and long-range strategic plan each year;
- The need to keep track of the business and technology innovations with increased pace and complexity and the new policies/regulations in in our industry;
- The research and analysis work needed to support the development and implementation of various business strategies;
- The number of company-wide active projects and analysis tasks supported by the team and their complexity;
- The amount of research, analysis, and financial modeling work needed to support the development and implementation of new product and service offerings to our customers;
- The number of research and analysis tools and business processes managed by the group; and
- Outside information service requirements by various industry groups and public organizations.

4. Cost Allocation (Shared Service)

Activities in the Business Strategy and Development organization provide benefit to both SoCalGas and SDG&E customers. Costs are allocated based on natural gas revenues as a proxy for the benefit to each utility. The allocation methodology for this cost center can be found in my workpapers (Exhibit SCG-21-WP).

V. CONCLUSION

The activity areas in my testimony cover a variety of functions and activities that support policies and technologies that optimize the use of natural gas as an environmentally beneficial and cost-effective energy solution, enhance safety and reliability of the natural gas delivery

system, support customer adoption and use of low-emission technologies, and support a variety of statewide initiatives in related areas.

The incremental funding requirements supported in my testimony are driven by state and federal policies, regulations and legislation requiring dramatic reduction in GHGs, PM and smog-causing pollutants. These overall policy goals are driving a proliferation of new legislation, proposals and regulations to achieve these goals. SoCalGas' activities are carried out to protect the interests and safety of customers and ensure that policy goals are achieved in the most cost-effective manner, with costs fairly allocated across sectors and with natural gas and the natural gas system utilized to maximum benefit. This drives activity in legislative, regulatory and policy analysis, assessment of economic and environmental impact of proposals, agency interaction, stakeholder outreach and direct support for customers. It also creates the need for increased activity to assess and advance technologies that improve the emissions profile of natural gas, make available future supplies of RG, and enhance system safety and reliability.

This concludes my prepared direct testimony.

VI. WITNESS QUALIFICATIONS

My name is Lisa Larroque Alexander. My business address is 555 W. Fifth Street, Los Angeles, California. I am the Vice President of customer solutions and communications for SoCalGas, a Sempra Energy regulated California utility. I am responsible for delivering clean, low emissions energy solutions for commercial, industrial and residential customers; and delivering the information, programs and services to meet customers' energy needs and support state environmental and social policy objectives. My business portfolio includes renewable gas, near zero emissions transportation, emerging technologies, research and development, energy efficiency, conservation and low income assistance programs as well as media, customer and employee communications. Previously at the company, I held increasingly responsible management roles in the areas of commercial and industrial services, customer strategy and new products and services.

Prior to joining SoCalGas, I was a partner at a consulting firm that advised energy companies on behavioral economics, demand response and conservation; and smart grid technologies. I have also held management positions at E*TRADE, Ticketmaster and Omnicom companies, and as a consultant with Ernst & Young and Accenture, have advised Fortune 500 companies on strategy matters. I began my career as a management consultant with Accenture (Andersen Consulting at the time.)

I am currently serving as vice-chairman of the California Natural Gas Vehicle Coalition, and serve as a director on the boards of the United Way of Greater Los Angeles, TreePeople and the Natural Gas Vehicle Association. I also serve on the advisory board of Mobility 21 and am a member of the California Retailers Association. I hold a bachelor's degree in political science cum laude from the University of California, San Diego.

I have not previously testified before the Commission.

APPENDIX A
Summaries of Legislative, State Agency and Local Government Efforts to Advance and Support Environmental Quality and Public Health and Safety Goals

GHG Reduction Efforts

- SB 32 Global Warming Solutions Act sets a total statewide GHG reduction goal of 40 percent below 1990 levels by 2030, to be achieved by ancillary policies, such as the low-carbon fuel standard, cap-and-trade, renewable portfolio standard, and the methane reduction goals set forth in SB 1383.
- SB 350 Clean Energy and Pollution Reduction Act sets a 50 percent renewable portfolio standard by 2030 and a doubling of energy efficiency by 2030.
- SB 1383 Short-Lived Climate Pollutants and RG requires the CARB to develop and implement a plan to reduce emissions of short-lived climate pollutants, including methane. As part of the requirement, the CEC will include a recommendation in the 2017 IEPR on the development and use of renewable gas.
- SB 1371 GHG Emissions Mitigation: SB 32, signed into law on September 8, 2016, set a statewide goal to reduce GHG emissions to 40% below 1990 levels by 2030. This legislation builds on Governor Brown's 2015 Executive Order, B-30-15,[27] setting the same target. Meeting this target requires dramatic advances in efficiency and development of RG and low-carbon resources. SB 1371 specifically directs the Commission to develop and implement a comprehensive natural gas pipeline leak reduction strategy that ensures that companies identify and quickly and efficiently repair methane leaks consistent with established safety requirements and the goals of reducing climate change impacts from methane emissions.

Air Quality Efforts

- The Federal CAA requires US EPA to set NAAQS for six common air pollutants – carbon monoxide, ground-level ozone, lead, NOx, PM and sulfur dioxide.

[27] EO-B-30-15 sets a greenhouse gas (GHG) emissions target for 2030 at 40 percent below 1990 levels. http://www.climatechange.ca.gov/state/executive_orders.html.

- AB 617: requires the CARB and all of the air districts in which the company operates (10 total) to develop and implement a number of new programs for criteria air pollutants and toxic air contaminants.
- Air Quality Management Districts: The local Air Districts must develop plans and rules[28] to ensure attainment of six criteria pollutants pursuant to the CAA.[29] The development of the AQMP and implementation rules require diverse stakeholder engagement and have evolved into multi-year proceedings. For example, the SCAQMD's 2016 AQMP took three years to develop and included a variety of advisory and working group meetings to identify available technologies and evaluate different alternatives. With adoption of the AQMP, the District has now moved into a series of ten working groups to help guide development of rules over the next three years. SCAQMD is scheduled to submit their next ozone AQMP in 2019. The ozone plans have required attainment dates of 2023 and 2031. So, this cycle of plan development and rule-making will continue with greater urgency and less time for implementation. Similarly, the SJVAPCD is developing an AQMP to meet PM attainment by 2025, and will also develop an updated ozone plan within the next few years.
- NOx and PM Emissions Reductions: The NAAQS under the CAA requires substantially lower fine PM and 8-hour surface-level ozone standards. These new standards require southern California to significantly accelerate its criteria pollution reduction efforts over the next decade. Meeting the standards will require reduction of NOx emissions of 80% or more in the SCAQMD and SJVAPCD by 2023 and 90% by 2032.[30]
- IAQ: CARB and the CEC both have programs to examine indoor air quality.

[28] SCAQMD has almost 300 Rules and 20 active Rulemaking activities, which can impact SoCalGas operations or a variety of customers- commercial cooking, residential space and water heating, non-refinery flaring operations, facility caps for regional goods movement centers, industrial facilities and electric generators. Similarly, SJVAPCD has 144 existing rules and 6 active regulatory activities.

[29] The Federal Clean Air Act requires US EPA to set NAAQS for six common air pollutants – Carbon Monoxide, ground-level Ozone, Lead, NOx, PM and Sulfur Dioxide.

[30] CARB, SCAQMD, SJVAPCD, Vision for Clean Air: A Framework for Air Quality and Climate Planning at 4, *available at*: https://www.arb.ca.gov/planning/vision/docs/vision_for_clean_air_public_review_draft.pdf (2012).

Renewable Resource Efforts

- Renewable Portfolio Standard: The state has in place the aggressive goal of increasing energy procured from eligible renewable energy resources to 50% of total procurement by 2030.[31] At the time of this writing, state legislators are evaluating even more bold renewables targets. Integration and firming of renewables is a growing concern for California and technologies at the intersection of the natural gas and electricity sectors can help address this need while increasing the utilization of existing natural gas infrastructure.
- Bioenergy Action Plan: The CEC's 2012 Bioenergy Action Plan outlines strategies, goals, objectives, and actions that California state agencies will take to increase bioenergy development in California. The 2012 Bioenergy Action Plan states that the bioenergy market is underdeveloped and that "despite its many benefits, bioenergy production uses only 15 percent of California's available biomass waste, and production is decreasing."[32] Executive Order S-06-06[33] also established a goal to produce 20% of renewable electricity from biofuels by 2020 and established goals for increasing production of total biofuels from in-state resources with that fraction increasing to 75 percent by 2050.[34]
- Low Emission Fuel and Vehicle Technology: California AB 692 Low Carbon Transportation Fuels (2015) requires state fleets to procure increasing volumes of alternative transportation fuels and Executive Order S-01-07 establishes a statewide goal to reduce: (1) the carbon intensity of California's transportation fuels by at least 10

[31] RPS was established in 2002 under SB 1078 and accelerated under SB 107 (Simitian, Stats. of 2006) and SB X1 2 (Simitian, Stats. of 2011). In 2015, Governor Brown signed SB 350, setting the 50% requirement by 2030. *See* Renewables Portfolio Standard (RPS), California Energy Commission, *available at*: http://www.energy.ca.gov/portfolio/.

[32] 2012 Bioenergy Action Plan at 2, Docket No. 10-BAP-01, California Natural Resources Agency, *available at*: http://resources.ca.gov/docs/energy_and_climate_change/2012_Bioenergy_Action_Plan.pdf (Aug. 2012).

[33] EO-S-06-06 directs Secretary of Cal/EPA to participate in the Bio-Energy Interagency Working Group and addresses biofuels and bioenergy from renewable resources. *See* EO S-06-06, Office of Governor Edmund G. Brown, *available at*: https://www.gov.ca.gov/news.php?id=183.

[34] Id.

percent by 2020, and (2) reduce petroleum fuel use to 15% below 2003 levels by 2020.[35] California Public Utilities Code Section 740.3 codifies the role of utility programs in facilitating the use of natural gas-fueled low-emission vehicles and supporting these goals.[36]

- The California Solar Thermal Initiative: Commission decisions D.13-02-018 and D.13-08-004 affirm their commitment towards expansion of solar thermal technologies and establish incentives for solar thermal applications for process heating, solar cooling, space heating and solar pool systems.

Energy Policy Efforts

- ZNE: The 2011 IEPR recommended triennial building standards updates that increase the energy efficiency of newly constructed buildings by 20 - 30 percent in every triennial update to achieve ZNE standards for newly constructed homes by 2020. The Report states that the adoption of a ZNE definition will enable the CEC to update the California Building Energy Efficiency Standards for 2016 and 2019 with clear orientation toward the upcoming ZNE targets for low-rise residential buildings in 2020 and nonresidential buildings in 2030.[37]
- DG and CHP: California Public Utilities Code Section 372(a) and Section 379.6(c)[38] and Energy Action Plan II[39] call for expended development of efficient, environmentally beneficial CHP. The CARB scoping plan for the implementation of AB 32 established a target for 4,000 megawatt (MW) of additional CHP capacity by 2020 to combat GHG

[35] EO S-01-07, Office of Governor Edmund G. Brown, *available at*: https://www.gov.ca.gov/news.php?id=5172.

[36] Cal. Pub. Util. Code § 740.3 ("The commission, in cooperation with…regulated electrical and gas corporations… shall evaluate and implement policies to promote the development of equipment and infrastructure needed to facilitate the use of electric power and natural gas to fuel low-emission vehicles.").

[37] 2013 IEPR at 38, *available at*: http://www.energy.ca.gov/2013publications/CEC-100-2013-001/CEC-100-2013-001-CMF.pdf.

[38] Cal. Pub. Util. Code §§ 372, 379.6.

[39] Energy Action Plan 2008 Update at 15, adopted by the CPUC, CEC, and California Power Authority, *available at*: http://www.energy.ca.gov/2008publications/CEC-100-2008-001/CEC-100-2008-001.PDF (Feb. 2008).

emissions.[40] In addition, Governor Brown has called for adding 6,500 MW of new CHP by 2030.[41]

- CEC 2017 IEPR: This update to the IEPR will continue to address ZNE requirements for new construction, as well as developing recommendations on RG, climate adaptation and resiliency, distributed energy resources and energy reliability issues. The IEPR is updated every two years, and SoCalGas works closely on these issues. The treatment of natural gas technologies in these regulations will have significant impact on natural gas.

Reliability and Safety Efforts

- Pipeline Safety and Reliability: The Department of Transportation's Code of Federal Regulations (49 CFR), the Commission's General Order 112-E, and the Commission's biomethane quality standards established new or enhanced natural gas pipeline safety and reliability standards or requirements. Examples include satellite and aerial leak detection, pipeline and ground movement detection sensors and robotic weld inspection technologies.
- County and Municipal Resilience and Sustainability Planning Efforts: Cities and counties are increasingly focused on resiliency planning, which helps ensure reliability of energy deliver and avoid gas shortages and power outages, resulting from climate change or other potential energy disruptions.

[40] Climate Change Proposed Scoping Plan: A Framework for Change at 43, California Air Resources Board, *available at*: http://www.arb.ca.gov/cc/scopingplan/document/psp.pdf (Oct. 2008).

[41] New Generation of Combined Heat and Power: Policy Planning for 2030 at 10, CEC, *available at*: http://www.energy.ca.gov/2012publications/CEC-200-2012-005/CEC-200-2012-005.pdf (Sept. 2012).

APPENDIX B
Technology Needs Assessment Summary

Customer End-Use Application RD&D

Project Area	Current Performance	Required Performance	Development Areas	SoCalGas RD&D Activities
Zero Net Energy for Residential Buildings	• Existing building codes do not require use of renewable technologies in new home construction.	• CEC is pursuing a strategy that would require all new residential homes in California to be ZNE by 2020. • By definition, a ZNE home generates onsite energy using renewable technologies to offset energy consumed on site using Time Dependent Valuation (TDV) methodology.	• Development and demonstration of new high efficiency gas appliances that are cost competitive with competing electric appliances. This would include development of less expensive condensing gas water heaters and space heaters, gas heat pumps and microCHP. • Home demonstrations: work with builders to demonstrate a package of gas products in ZNE model homes.	• Support manufacturers in the development of cost competitive condensing gas appliances, gas heat pumps, and microCHP products. • Develop new smaller size / Btu input rating space heating products for the ZNE tight construction home. • Support builders in the demonstration of gas appliance packages in model ZNE homes.
Appliance & Indoor Air Quality	• Current water heaters meet 10 nanograms per joule (ng/joule) NOx • Current central furnaces meet 40 ng/joule NOx • Residential ranges and ovens are not automatically vented • Condensing gas appliances offer Coefficient of Performance (COP) of 0.9. $70.03/MWh ~ $226.72/MWh	• NOx emissions: • 10 ng/joule NOx for water heaters • 14 ng/joule by April 2015 for residential condensing central space heating furnaces • 14 ng/joule by October 2015 for residential non-condensing furnaces • CMB-02[42] in 2016 AQMP discusses requirement of near zero emission products (not defined).	• Water heating: future regulations may require near zero NOx emission burner technologies below 10 ng/joule. • Space heating: need to demonstrate new 14 ng/joule NOx central furnaces and develop larger commercial size central furnaces that also meet 14 ng/joule and develop near zero NOx emission furnaces. • IAQ concerns may force development of range and oven designs that are automatically vented to the outside.	• Support industry developing/demonstrating new low NOx emission products for water heaters and space heaters. • Foster development of new combustion technologies using metallic, ceramic, and fiber materials. • Work with industry to define /validate IAQ concerns in homes. • Work with manufacturers to develop / demonstrate new gas heat pump products. • Foster development of lower cost condensing water heating and space heating technologies.

[42] Combustion Sources (CMB) Control Measures proposed in the SCAQMD 2016 Air Quality Management Plan for Stationary Sources. CMB-01 requires Transition to Zero and Near-Zero Emission Technologies for Stationary Sources [NOx, VOC]. CMB-02 requires Emission Reductions from Replacement with Zero or Near-Zero NOx Appliances in Commercial and Residential Applications [NOx]. CMB-04 requires Emission Reductions from Restaurant Burners and Residential Cooking [NOx].

		• Future IAQ mandates not defined. • Efficiency: Gas heat pump products will likely have COP of 1.2 to 1.5	• Gas heat pumps need to be developed that offer the consumer significantly higher operating efficiencies.	
Commercial Cooking & Food Service	• Commercial cooking equipment is not regulated for NOx; • Conveyor charbroiler is regulated for PM emissions	• Control measures CMB-04 and BCM-03[43] in the SCAQMD 2016 Air Quality Management Plan indicate future NOx and PM reductions will be required but do not provide emission levels (details will be worked out during future rule development proceedings).	• Characterize current NOx emissions from the many types of commercial cooking equipment • Develop low NOx commercial cooking equipment • Develop/demonstrate PM reduction methods / equipment to reduce PM from underfired charbroilers.	• Conduct study to characterize NOx emissions from commercial cooking equipment. • Support industry to develop and demonstrate new low NOx emissions food service equipment. • Support industry to develop and demonstrate new underfired charboiler PM control technologies.
Solar-Thermal Heating & Cooling	• Existing products perform up to codes and standards but economics can be challenging particularly at smaller sizes. • Concentrating solar thermal arrays often struggle with maintenance issues	• Cost competitive with gas fired solutions or photovoltaic arrays	• Develop / Demonstrate concentrating solar thermal arrays featuring increase reliability and low maintenance costs. • Reduce integration issues with systems producing multiple end use energy products such as steam, cold water, and or hot water	• Support manufacturers in developing cost effective solar thermal solutions for commercial and multifamily applications. • Demonstrate solar thermal arrays fueling absorption chilling systems with natural gas backup. The arrays can also supplement hot water and space heating needs outside of cooling season
Boilers & Process Heating	• Industrial / commercial boilers currently meet 5 to 20 ppm NOx depending on size and burner technology used. SCAQMD boiler rules 1146, 1146.1, 1146.2. SCAQMD process	• Control measure CMB-01 in the SCAQMD 2016 Air Quality Management Plan indicates additional NOx reductions will be required for boilers and industrial process heating equipment but does not provide emission levels (details will be worked out	• Develop / Demonstrate low NOx industrial boilers that can achieve near zero emissions • Develop / demonstrate low NOx industrial process heaters that can achieve near zero emissions.	• Support industry to develop and demonstrate new low NOx emissions boiler equipment. • Support industry to develop and demonstrate new low NOx process heaters.

[43] Best Available Control Measures (BCM) proposed in the SCAQMD 2016 Air Quality Management Plan for Stationary Sources. BCM-03 requires Emission Reductions from Under-Fired Charbroilers [PM2.5].

	heater rules 1147 and 1153. • Industrial process equipment (furnaces / dryers/ ovens) typically have NOx emissions between 30 and 60 ppm depending on process temperature.	during future Rule development proceedings).		

Clean Generation RD&D

Project Area	Current Performance	Required Performance	Development Areas	SoCalGas RD&D Activities
DG-CHP-MicroCHP	• MicroCHP products are currently unavailable in SoCalGas service territory. The main barrier is obtaining a product that can meet emissions requirements at small scale.	• CARB DG Certification standards require emission limits of 0.07 lb/MW-hr for NOx, 0.10 for carbon monoxide (CO), and 0.02 for volatile organic compounds (VOCs)	• Develop / Demonstrate small scale emissions control technologies. • Attract successful European and Asian vendors to the California market.	• Support manufacturers development of a CARB compliant MicroCHP products. • Demonstrate MicroCHP products. • Assist MicroCHP vendors in obtaining CARB certification
Engines & Turbines	• Current product offerings can meet emissions requirements with several major vendors active in various size ranges	• SCAQMD Rule 1110.2 requires emissions limits of 11 ppm NOx, 30 ppm VOCs, and 70 ppm CO for engines above 50 horsepower. • Rule 1134 requires emissions limits of 9 ppm NOx for turbines greater than 2.9 MW	• Identify new emissions reduction technologies and renewable fuel compatibility	• Support manufacturers efforts in developing and demonstrating novel emissions control strategies as well as devices that can make renewable fuels compatible with existing systems
Fuel Cells	• Current fuel cell offerings meet required emissions specifications but the number of vendors and product sizes are limited and cost is high.	• CARB DG Certification standards require emission limits of 0.07 lb/MW-hr for NOx, 0.10 for CO, and 0.02 for VOCs	• Develop / Demonstrate small scale fuel cells for single family and multifamily applications. • Attract successful European and Asian vendors to the California market.	• Support manufacturers efforts in developing and demonstrating novel emissions control strategies as well as devices that can make renewable fuels compatible with existing systems
Waste Heat Recovery	• Current product offering meet codes and standards but number of vendors and product sizes are limited. • Cost of units is high and conversion efficiency is low.	• Lower capital cost • Higher electrical conversion efficiency	• Develop and demonstrate new heat extraction methods and technologies including new materials and working fluids	• Demonstrate waste heat to power at a small commercial/industrial facility. • Monitor advancement of new technologies such as solid state thermoelectric devices and super critical fluids

Clean Transportation RD&D

Project Area	Current Performance	Required Performance	Development Areas	SoCalGas RD&D Activities
Compression & Refueling	• Current industry infrastructure is meeting codes and standards. • Refueling is still subject to inefficiencies and losses resulting in incomplete fills for users. • Capital costs for infrastructure and stations are still very high compared to normal stations.	• Full Fill refueling • Higher compressor efficiency • Lower compressor cost • State policies: AB 1007 - Increase the use of alternative transportation fuels. AB 32, Executive Order S-01-07 – 10% Reduction in carbon intensity of California's transportation fuels by 2020 (natural gas is a LCFS[44], 29% lower GHG than gasoline and 15% less than diesel).	• Full fill dispensers • Reduce natural gas station capital cost • Improve compressor efficiency • Reduce compressor cost	• Demonstrate advanced full fill methods • Support and co-fund compressor technology development with various technologies
Fuel Systems & Storage	• Tier 1-4 CNG storage cylinders are readily available for consumers. Each type has its own benefits, but mostly type 3 and 4 cylinders are used for transportation due to weight and cost benefits. • Original equipment manufacturers (OEMs) are also increasing "virtual pipeline" applications for improved storage.	• Adsorbent and conformable storage tanks capable of operating at 500-1000 psi. • State policies: AB 1007 - Increase the use of alternative transportation fuels. AB 32, Executive Order S-01-07 10% reduction in the carbon intensity of California's transportation fuels by 2020 (natural gas is a LCFS, 29% lower GHG than gasoline and 15% less than diesel).	• Develop lower cost carbon absorbent materials and manufacturing costs • Develop alternative options for conforming tank configurations for various Light Duty, Medium Duty and Heavy Duty vehicles (HDV) • Improved composite tank safety device/installation protocol to avoid rupture in a localized fire	• Demonstrate and commercialization ANGP[45] conformable storage tank, with partnerships including General Motors, United Technologies, and other entities. • Seek out and support lighter weight storage systems for absorbent and conformable tanks.

[44] LCFS is the California Low Carbon Fuel Standard program administered by CARB.

[45] Adsorbed Natural Gas Products, Inc. (ANGP) is leading the industry in commercializing low pressure on-board adsorbed natural gas (ANG) storage technology/

Near Zero Emissions Engines	• Present on-road Tier 4 emission standards are at 0.2 g/bhp-hr • Current Medium-Heavy Duty Truck engine meet Near-Zero Emissions (0.02g/bhp-hr). • Larger (12L) and smaller (6.7L) displacement natural gas engines are still being developed.	• Near-Zero emission (NZE) engines in all heavy-duty applications from 6.7L to 15L for various vocations commercially available	• Integrate available natural gas engines into more models and applications by OEMs, in all weight classes • Develop a broader range of natural gas HDV engine sizes and applications • Develop a broader range of natural gas HDVs with improved engine economics, efficiency, and emissions including NZE engines and various hybrid drive developments	• Demonstrate 12L NZE heavy duty engine along with plans to bring smaller displacement engines to NZE (6.7L, 6.8L, 8.8L).
CNG & Hybrid Vehicles	• Present on-road Tier 4 emission standards are at 0.2 g/bhp-hr. • AB 118 (2007) created the CEC's Alternative and Renewable Fuel and Vehicle Technology Program to deploy alternative and renewable fuels and advanced transportation technologies. • CNG Hybrid technology is being developed and there are several demonstrations of the technology from US Hybrid, TransPower, EDI, and others	• CNG Hybrid technology needs to be commercially available as an option for fleets and consumers to consider	• Develop CNG-Hybrid technology to allow further NOx and GHG emission reductions • Allow further range capability of electric technology with the addition of CNG to alleviate range anxiety • Monitor automotive OEM activities to keep pace with vehicle development	• Develop & demonstrate CNG-Hybrid technologies for Class 8 vehicles. • Develop and demonstrate CNG hybrid applications for various vocational vehicles
Off-Road (Locomotives, Construction & Marine)	• CNG off-road applications for locomotives and construction equipment are not available to consumers.	• CNG off-road applications for locomotives and construction equipment need to be readily available commercially and need to meet NZE (0.02 g/bhp-hr) or better than Tier 4 emissions standards set by US	• Develop and demonstrate low NOx natural gas Locomotives • Improved Efficiency of off-road natural gas engines and technology • Develop Low NOx LNG Vessels • Develop Low NOx natural gas Construction Equipment	• Develop & demonstrate Low-NOx Switch Locomotive and Low-NOx construction equipment through the CEC and SCAQMD

	• Maritime applications are leading the way with liquefied natural gas (LNG) bunkering and vessels throughout the world. • Tier 4 emission set by US EPA and CARB: Heavy-Duty Off-Road = 0.3 g/bhp-hr, Locomotive - Line = 1.3 g/bhp-hr, locomotive - switch = 1.3 g/bhp-hr, Marine = 2.6 g/bhp-hr	EPA and CARB for off-road applications		

Low Carbon Resources RD&D

Project Area	Current Performance	Required Performance	Development Areas	SoCalGas RD&D Activities
Biomass Gasification	• Biomass gasification is technically proven at scale • Each system is custom designed and fabricated based on feedstock and siting • Operator costs are substantial • Optimal system size is uncertain • Cost of produced biomethane is above $10/MMBtu	• Standard designs and system sizes for specific feedstocks and locations • Proven robust and durable systems • Cost of produced biomethane below $5/MMBtu	• Standardized, skid mounted system designs • Autonomous, low-maintenance systems • Feedstock resources mapping and site selection optimization	• Collaborate with CEC, DoE and others to deploy pilot commercial systems • Support research to map feedstock supplies and infrastructure requirements to identify optimal development locations.
Power-to-Gas (P2G)	• 150 kW electrolyzer demonstration in US. • 1 – 10 MW P2G systems with biomethanation available in Europe. • Poorly understood grid integration attributes • Two-steps: electrolysis then blending or methanation • Cost: $70.03/MWh ~ $226.72/MWh	• 1 – 50 MW scale • Standard skid mounted systems • Grid models showing integration of power, batteries, P2G storage • Direct, one step, power-to-methane systems • Cost: $51/MWh ~ $151/MWh	• Modeling of the efficiency and value of wind and solar resources coupled with batteries, P2G, and various energy transmission rules and policy options. • Renewable power resource mapping and site selection optimization	• 1 – 50 MW scale pre-commercial pilot demonstrations • Optimized, utility scale P2G system designs • Grid scale modeling to guide public policies • Develop electrochemical CO_2 reduction technology to convert excess renewable power directly to methane • Bioelectromethanogenesis pilot commercial demonstrations
Artificial Photosynthesis	• Lab scale investigations • Photo-water splitting is more advanced than CO_2 reduction • High cost • Catalytic materials degrade quickly	• Large scale, robust 1 MMCF/day systems • Methane selectivity >90% • Cost <$5/MMBtu	• Membrane material • Catalytic materials • Control systems • System design	• Support for Joint Center for Artificial Photosynthesis • Support for field tests

Carbon Capture & Use	• Lab scale capture systems • CO_2 use limited to enhanced oil recovery (EOR) • Co-location to flue gas source required	• Renewable energy based systems • CO_2 capture cost <$30/ton • Large scale end-uses for CO_2 including fuels, chemical, materials	• Material development • Solar- and wind-based CO_2 capture systems • Ambient air capture systems • Cement, building materials, chemicals and other large-scale sinks	• Research reactive membranes, sorbents, and solvent systems with optimal capture properties • Pilot-scale technology demonstrations
Hydrogen Production from Methane	• Large refinery scale systems • Small distributed systems being tested	• Distributed hydrogen production systems integrated with Fuel Cell Electric Vehicle (FCEV) fueling and industrial end-uses • Renewable energy based steam-methane reforming systems • Zero carbon emissions	• Catalysts • Thermally efficient reactors • Process design coupling with renewable energy resources • Low-cost manufacturing • Commercialization • Integration with FCEV refueling systems • Integration with industrial end-uses such as refineries and metal treatment facilities	• System commercialization • Pilot demonstrations at FCEV facilities • Pilot demonstrations at industrial facilities • Develop electrochemical reduction technology to convert CO_2 to chemicals and fuels

Gas Operations RD&D

Sub-Program	Project Area	Current Performance	Required Performance	Development Areas	SoCalGas RD&D Activities
Environmental & Safety	**Damage Prevention**	• Buried gas facilities are marked for pending excavation per California regulation (DigAlert). Passive systems provide a visual indication that gas pipe is within a conflict zone • Aboveground gas meters are protected by ballards and meter guards against vehicle damage	• Improved passive alert systems and new active alert systems • Breakaway shutoff device for aboveground gas meters	• Develop and evaluate enhancements or modifications to existing damage prevention solutions: passive alerts and damage from vehicles. Develop, demonstrate and deploy advanced sensors and monitoring systems to alert pipeline operators of third party encroachment and construction activities near pipeline right-of-ways. These sensors can be installed directly onto the pipeline, in the surrounding soil and on excavation equipment. • In addition, automatic shutoff systems for above- and below-ground piping system are being developed to minimize the release of natural gas from damages caused by vehicles or excavators.	• Develop in-house and/or through research consortiums like NGA/NYSEARCH and Operation Technology Development (OTD), and government agencies. • Provide host sites for field tests.
	Emissions Detection	• Federal and State requirements for reporting GHG emissions: AB 32, US EPA Subpart W, The Climate Registry (TCR), Methane Challenge (Gas Star)	• State agencies (CARB, CPUC) developing tough new standards regulating methane emissions requiring detection and monitoring, reporting and reducing emissions. Regulatory proceedings include SB 1371, SB	• Develop and evaluate methane sensors that are sensitive, inexpensive, accurate, and easy to use. Sensors may be utilized in equipment that is stationary, mobile, or aerial and constructed to perform point, perimeter, area, continuous or instantaneous monitoring. Sensors that are able to speciate methane emissions differentiating between pipeline	• Develop and implement best operating practices to mitigate methane emissions. • Enhance the ability of methane detection system to detect and monitor low level methane emissions, improving the sensitivity, reducing the size and cost of the equipment. Possible technologies include Optical Gas Imaging Systems, General Electric Hollow Core Optical

			877[46], CARB proposed Oil & Gas Rule, and proposed local air district regulations. • Indoor methane emissions (from pipes and appliances) are currently being studied and may lead to performance standards.	gas and other sources of methane, which may be upstream or downstream of the system of interest (aboveground or buried).	Fiber, Bioinspira Colorimetric Sensor, and Leek Polymer Absorptive Sensor.
	Emissions Quantification	• Federal and State requirements for reporting GHG emissions: AB 32, US EPA Subpart W, TCR, Methane Challenge (Gas Star). • Reported fugitive emissions are based on emission factors that were determined by national studies and are not necessarily representative of our system	• Better characterize emissions to reduce uncertainties around GHG estimates by improving current emission factors, developing leak rate emission factors • Ability to identify potentially large leaks	• Develop technologies to quantify methane emissions from above and below ground sources including Optical Gas Imaging, mobile systems, surface expression, direct measurement equipment. • Determine the relationship between leak rate vs. time on PE pipe susceptible to slow crack growth. • Develop decision tree for identifying potentially large leaks. • Identify and quantify un-studied methane emissions from natural gas compressor equipment.	• Develop in-house and/or through research consortiums like NGA/NYSEARCH and OTD, and government agencies. • Provide host sites for technology field tests.
	Environmental	• No current standards or guidelines for Climate Change Impacts and Adaptation • Control of methane emissions is not	• State agencies like the CEC and CARB strongly recommend that utilities perform climate change studies and develop adaptation plans. New and proposed regulations will require control or	• Develop methodology for assessing impact of climate change on the gas system and develop best practices for mitigating impacts. Include impact of ground subsidence in the San Joaquin Valley caused by drought.	• Conduct internal study to demonstrate the resiliency of the gas system to climate change. • Develop technology in-house or through research consortiums like NGA/NYSEARCH, and OTD. • Provide host sites for field tests.

[46] SB 887 (2016) Natural gas storage wells.

		required, but best practice is to reduce emissions associated with planned activities	reduction of methane emissions. • Flares/thermal oxidizers may be required, which could create implementation timing and air permitting issues	• Demonstrate viability of catalytic flares or thermal oxidizers to control compressor methane emissions. Identify alternative methods which are cost effective and deployable across various operating conditions such as flaring and recapture of blowdown gas to eliminate methane emissions	• Deploy sensors near major facilities.
Operations Technology	**O&M Technologies**	• Repair of damaged polyethylene (PE) pipe requires pressure control, installation of gas bypass system to ensure no disruption of gas service. • Existing locating technologies are designed to detect buried steel gas facilities or plastic pipe containing a conductive wire. They do not locate non-conductive underground substructures. • Inaccessible Right-of-Way locations requiring compliance inspections can be time consuming and pose a safety hazard • Comply with Occupational Safety and Health Administration (OSHA) requirements. Personnel working in a flammable environment	• Cost effective methods of repairing damaged PE pipe without concerns of gas disruptions. • Advanced mapping technologies that can produce accurate images allowing differentiation of multiple buried facilities. • Use of Unmanned Aircraft Systems (UAS) for compliance leakage surveys and visual inspections along inaccessible Right of Way locations reduces the risk to operators. • An automatic flash fire suppression system would add another level of protection to utility personnel working in a flammable environment.	• Develop composite repair wraps, adhesive patches or polymer encapsulation systems that are easily applied over the damaged section. • Further enhancement of acoustic, electromagnetic and ground probing radar systems to produce complete images of buried substructures. • Develop and integrate advanced imaging and leak detection technologies onto a Drone to conduct compliance inspections of difficult to access facilities. • Further enhancement of a prototype flash fire suppression system through OTD and support the commercialization effort to bring the product to market.	• Develop in house and/or through research consortiums and provide host sites for field tests.

		are equipped with fresh air supplies, gas extraction suit and harness. Fire extinguisher is located nearby and operated manually by another personnel.			
System Design & Materials	**Compressor Technologies**	• Reciprocating compressor rod packing leaks under normal operations. Current GHG regulations require measuring and reporting compressor vent and seal emissions: AB 32, US EPA Subpart W, TCR, Methane Challenge (formally Gas Star) • Legacy natural gas engine driven reciprocating compressors are operating with scheduled maintenance intervals based on hours of operations and repairs due to abnormal operating conditions.	• Further reduce or eliminate methane emissions from rod packing. • Regulations are being developed which establish best practices and thresholds for compressor vent emissions: SB 1371, CARB proposed Oil and Gas Rule, and local air district regulations • Increase operation efficiencies with continuous monitoring of critical operating parameters for both engine and compressor systems.	• Develop methods to capture the leaked gases and transfer it safely back into the pipeline system or control it such as with a thermal oxidizer. Develop newer rod packing designs and piston rods with special coatings to keep leakage rates low for a longer period reducing wear. • Develop advanced diagnostic systems with continuous engine/compressor monitoring of critical parameters to forecast impending problems and only schedule maintenance work when required.	• Develop through research consortiums like Pipeline Research Council International (PRCI) and provide host sites for field tests.
	Engineering & Design	• Pipeline corrosion protection (CP) is addressed using established standard industry methods; pipe coating, impressed current and sacrificial anodes.	• Maintain reliability of CP systems by mitigating external factors that may reduce the effectiveness of CP	• Research areas of interest include use of fuel cell rectifiers, AC corrosion modeling, and assessment of CP shielding parameters, high voltage Direct Current (DC) interference, and impact of	• Develop through in-house research and through consortiums like PRCI and OTD. Provide host sites for field tests and/or provide internal resources to evaluate and assess methods, models or technologies.

	• Routine pipeline construction and installation follow industry standards and best practices to minimize any resulting stress/strain that may reduce the lifetime performance of the pipe. • Current industry guidelines for pipeline welding of girth and long seams have produced excellent long term performance. • Normal operating and maintenance of natural gas underground storage fields facilities per current industry standards. • Pipeline and underground storage infrastructure risk management follows requirements for code compliance and use relative and qualitative risk models. • Transmission pipelines are constructed, tested, operated and maintained in compliance to all federal and state	• Additional guidelines are needed to mitigate other stresses/strains that may occur and impact pipeline integrity. • Acceptance criteria for girth welds on misaligned pipe, improve the reliability of semi-automatic welding, tools for effective welding processes and procedures, and identify factors impacting integrity of Electric resistance welded (ERW) long seam pipe. • Improve storage field operations and reduce maintenance costs in the areas of methane hydrate formation and adsorbent processes to remove VOCs and other contaminants. • Expand the company's risk management program to include probabilistic risk modeling, holistic enterprise approach, and more quantitative models. New and proposed regulations define specific elements to be included in a Risk	Alternating Current (AC) earth faults • Develop guidelines to; address geohazards (seismic, landslides and subsidence), surface loading on shallow burial depth, and the lowering/lifting of large diameter pipelines. • Develop new guidelines to improve welding processes, address abnormal conditions, and sub-standard ERW long seams. • Develop technologies to improve system operations during gas injection and withdrawal operations. New technologies are focused on early detection of methane hydrate formation on withdrawal lines, new absorbent material to remove contaminants like Siloxane, and a more efficient absorbent regeneration system. • Develop risk management tools to address; probability and severity of an incident, determine how risk change within a timeframe, amount of dollars spent vs. amount of risk reduction received, financial cost of various risks throughout the company, and use GIS for planning and risk mitigation. • Develop industry standard to establish safe distances when	

	regulations, and company policies.	Management Plan: DOGGR, PHMSA[47] • Guidelines to address safety when strength testing using nitrogen, and procedures for purging large diameter out-of-service pipelines.	strength testing high pressure pipelines with nitrogen. Develop best practices for purging 30" and larger out-of-service Transmission lines.	
Gas Composition & Quality	• Existing natural gas delivery and storage infrastructure, and combustion equipment were designed to operate based on the composition of traditional natural gas. • Natural gas quality from some local producers are measured using expensive online gas chromatographs (GCs) to ensure it does not exceed specific limits. Biomethane producers from landfill/wastewater sites may enter the pipeline network in the future and certain constituents cannot be measured using existing GCs.	• Comply with the California Global Warming Solutions Act under AB 32 to reduce GHG emission, and reduce carbon footprint of pipeline gas. • Low cost online analyzers to measure important natural gas components are needed to ensure producer gas meets our gas quality specifications.	• Identify trace constituents and establish upper limits for accepting renewal biomethane. Identify barriers that would prevent the introduction and blending of 10%-20% hydrogen into our existing infrastructure and customer combustion equipment. • Develop cost-effective miniature online VOC and Siloxane analyzers that has the detection levels and accuracies of laboratory equipment.	• Develop through in-house research and through consortiums like OTD, NYSEARCH, and HYREADY[48]. • Develop through in-house research, and consortiums like OTD and PRCI, and provide host sites for field tests.

[47] DOGGR is the California Department of Oil, Gas and Geothermal Resources. PHMSA is US Department of Transportation Pipeline and Hazardous Materials Safety Administration

[48] HYREADY is an initiative to study how to prepare natural gas pipelines to be ready to accept hydrogen into the system.

	Materials & Equipment	• Orifice plates and ultrasonic flow meters are used to measure large volume gas flow rates. Their design and installation configurations comply with all industry standards and Company specifications to ensure accuracy. • Materials used in Polyethylene (PE) pipeline system comply with ASTM[49] D2513 and all referenced specifications. • Company PE fusion procedures were established following the guidelines from the Plastic Pipe Institute, GTI technical reports, and extensive in-house testing. • Quality control of PE materials and fusion processes is essential to ensure long-term performance of the plastic piping system. There are insufficient industry guidelines and	• There is a continuing need to enhance metering accuracies through better knowledge of; installation designs, increased calibration frequencies, impact of acoustic and flow pulsations, and orifice geometries. • Further enhancements to PE materials will reduce risks of leakage and improve locate capabilities for PE pipe to reduce 3rd party damages • Establishing best practices on PE fusion processes will show Federal and State regulators that Company policies are in compliance with these acceptable methods. In addition, automating fusion processes will ensure consistent fusion quality. • Enhancements to ASTM D2513 is needed to address PE pipe ovality and out-of-round dimensional issues affecting quality of joints. A non-destructive method to assess quality of PE	• Assess the impacts on metering accuracy from: installation configuration, in-situ proving techniques (.5-1% accuracy), recalibration and pulsations (acoustic and flow) effects on ultrasonic flow meters. Geometric tolerance influences on orifice metering. • Develop alternative cap designs for PE tapping tees to eliminate any potential leak path and alternative tracking/locating technologies such as the integration of Radio-frequency identification (RFID) tags onto PE pipe. • Develop best practices for fusion joining preparations and processes, and technologies to semi-automate the saddle fusion of PE fittings. • Develop new acceptable limits for PE pipe ovality and out-of-round dimensions and incorporate into ASTM D2513. Develop a new Non-Destructive tool to allow quality control inspection of PE fusion connections.	• Develop through in-house research, and consortiums like OTD, NYSEARCH and PRCI, and provide host sites for field tests.

[49] **ASTM International** is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services. Some 12,575 ASTM voluntary consensus standards operate globally.

		inspection tools to address critical aspects of PE systems. • No guidelines or industry standards exist to manage certain risk in both the Steel and PE pipeline systems. • Natural Gas pneumatic devices are a defined source for GHG inventories and reporting- low bleed and intermittent are installed as a best practice. • The existing compressor system was designed to support Season based System Requirements which allowed longer operating cycles for compressors	joints is essential to ensure long-term performance. • Similar to ASTM F2897 for PE materials, a similar traceability encoding standard is needed for steel pipeline materials. New guidelines on PE installation in soils containing heavy hydrocarbons and methods to mitigate slow crack growth on vintage PE pipe subjected to squeeze-off pressure control operation. • New standards and regulations are being developed for reducing methane emissions. SB 1371 best practice will require replacing high bleed pneumatics. • The current energy environment including renewable sources, has changed the way the gas system is managed which results in short compressor operating cycles	• Develop a tracking and traceability encoding system and establish an ASTM standard for steel pipeline and components. Assess the impact and develop guidelines on the impacts of mechanical joints on PE pipe exposed to heavy hydrocarbons. Assess the ability of mechanical clamps to neutralize stresses on squeeze-off areas of vintage PE pipe to mitigate slow crack growth. • Develop and evaluate components (or systems) that are no-bleed and/or that do not vent or require gas venting to test operability or perform maintenance. • Determine the impact of increased on/off cycling on natural gas compressor equipment	
System Inspection & monitoring	**Storage Field Downhole Technologies**	• Well mechanical integrity testing performed per existing regulations.	• New and proposed regulations for Storage injection and withdrawal wells: DOGGR • Increased frequency and types of inspections	• Develop and evaluate technologies to address new requirements and standards of operation for storage wells • Develop inspection tools which do not require removal of well	• Develop through research consortiums, manufacturers, universities, and in-house. • Provide host sites for field tests.

			• Increased monitoring and data collection	inner tubing reducing time and cost • Improve data management and/or instrumentation for data collection	
	Pipeline Inspection Technologies	• Internal steel pipelines inspections performed with smart pigs and robotic platforms employing Magnetic Flux Leakage technique, and external inspections use direct assessment methods to assess coating conditions, material defects and corrosion damages. • PE pipelines are inspected visually when an area is exposed for other maintenance activities.	• Expand the capabilities of internal and external inspection technologies on in-service steel pipelines to identify smaller material and construction defects. • Expand the capabilities of internal and external inspection of in-service PE pipelines to identify material and construction defects.	• Develop new sensors, tools and robotic transport systems such as; auto ingress/egress of the Explorer robot system, eddy current and electromagnetic acoustic transducer crack sensor for Explorer robotic system, inline inspection corrosion sizing models, and new modules and technologies to enhance Explorer's capabilities and increase operational efficiencies • Perform assessment on viable inspection technologies for PE pipe.	• Develop through research consortiums like OTD, NYSEARC, and PRCI • Provide host sites for field tests.

APPENDIX C

RD&D Benefit/Cost Analysis

SoCalGas commissioned the Gas Technology Institute (GTI) to perform a benefit/cost analysis of end-use efficiency technologies, renewable gas technologies, and operation and pipeline and distribution safety technologies being developed with the support of the SoCalGas RD&D program. The assessment covered the period 2012-2016 and employed the Total Resource Cost (TRC) Test methodology. It was conducted for 286 active RD&D projects during the period 2012-2016. The TRC test analysis focused on three program areas:

1. Advanced, high-efficiency end-use technologies for core residential, commercial (including natural gas vehicles), and industrial customers that will reduce gas use, lower energy bills, and reduce CO_2, NOx, and other emissions.
2. Renewable biogas introduced into the SoCalGas transmission and distribution system, and other renewable gas technologies.
3. Advanced technologies for performing engineering, operations, and integrity management function.

The key findings:

- The Net Present Value (NPV) of customer benefits is $7.2 billion compared to NPV of costs of $5.2 billion, resulting in a benefit/cost ratio of 1.4/1.
- CO_2 savings of 9.3 million tonnes and NOx savings of 9,022 tonnes over the fifteen-year evaluation period.

The methodology is based on a gas customer perspective using an approach similar to the TRC in the Commission's Standard Practice Manual.[50] This approach is consistent with the methodology used to analyze the benefits of RD&D expenditures for the 2009-2013 timeframe submitted with the previous GRC filing. The costs and benefits associated with each project are totaled, and a ratio of benefits to costs is developed. For a project to be accepted, the benefit/cost ratio must exceed 1/1.

[50] Energy Efficiency Policy Manual V.5: Applicable to post-2012 Energy Efficiency Programs, R.09-11-014, CPUC, *available at*: http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/EEPolicyManualV5forPDF.pdf (July 2013).

Benefits and costs were carried out to 2030 using a societal discount rate of 8.03% to calculate NPV. If a technology was put in place in 2029, full first costs of the technology were included, but only one year of benefits, as the analysis was truncated in 2030. These assumptions assure a conservative analysis.

Economic benefits for end-use efficiency projects were calculated in terms of energy savings, energy bill reductions, CO_2 reductions, NOx reductions, and first cost savings. Each technology was evaluated against the best available competitor. Costs for the end-use efficiency technologies included installed first costs of the equipment, operating costs (mostly fuel costs) maintenance costs, replacement costs (if applicable) and emissions (including CO_2 and NOx). The competitor (gas, electric, or oil-based) was then evaluated on a similar cost for operating costs, maintenance costs, replacement costs (if applicable), and emissions.

The economic benefits used for renewable gas technologies included reduced use of natural gas (both quantity of gas and cost of gas), and reduced CO_2 and NOx emissions. Related transmission and distribution savings, where applicable, were also included in the benefit. Costs included the (usually) higher costs of renewable gas compared to fossil-based natural gas.

Determining the economic benefits for operations and pipeline and distribution safety technologies involved identifying the type of cost savings that would be achieved with each technology, evaluating a quantitative cost savings for each technology, estimating an implementation schedule, calculating actual cost savings based on rate of adoption, incorporating implementation costs including equipment, training, operation and maintenance), and then totaling all savings and costs.

APPENDIX D

RD&D Summary of Significant Recent Projects

The following RD&D program projects focus on six key objectives:

- Develop and implement technologies that enhance the safety and efficiency of SoCalGas' operations.
- Develop and demonstrate low-emission, high-efficiency equipment for residential, commercial, and industrial applications.
- Develop and demonstrate technologies that substantially reduce NOx & GHG emissions and comply with or exceed all air quality regulations.
- Advance the use of natural gas vehicles to help customers to decrease their dependence on other higher cost fuels and meet California's emissions standards.
- Increase the viability of clean, highly efficient, cost-effective distributed generation and CHP systems.
- Develop new renewable gas resources to meet California's aggressive renewable portfolio standards.

Customer Applications

Zero Net Energy Assessment

Evaluated how several baseline mixed-fuel and electric-only homes could cost-effectively reach ZNE goals through an optimized suite of advanced building technologies. Key findings in this assessment showed that mixed-fuel ZNE homes have several advantages over electric-only ZNE designs in most location/home size combinations, including: smaller photovoltaic (PV) system size, lower incremental costs, and higher TRC values. In 2016, the model was updated with improved appliance cost data and with new TDV values.

Effects of Biogas on Commercial Cooking Equipment

This study investigates the effects of reducing the Rule 30 Higher Heating Value (HHV) lower limit of 990 Btu/scf to 974 Btu/scf (biogas) on commercial natural gas cooking equipment. In 2016, testing was completed on fryers, underfired charbroilers, convection ovens and griddles. Tests results indicate that reducing the lower heating value of gas to 974 Btu/scf will not create a safety concern for commercial cooking equipment.

Demo of Ribbon Burner

Developed various process heater ribbon burner designs that meet NOx emission targets ranging from 20 to 60 parts per million (ppm) depending on process temperature. In 2016, GTI and Flynn Burner Company completed the design and ordered all the materials for the demonstration project. A full-scale demonstration of this ribbon burner technology will be initiated in 2017 on an industrial baking oven at Western Bagel in Van Nuys, California.

Ultra-Low NOx Boiler

Demonstrate a novel Ultra-Low NOx commercial fire tube boiler technology using Dynamic Staged Entrainment burner technology, capable of achieving NOx emissions below 5 ppm without the use of selective catalytic reduction. This demonstration prototype was successfully installed and source tested at Mission Linen in Santa Barbara in the 4th quarter 2016. Boiler performance testing will be conducted throughout 2017.

Indoor Air Quality Study

This study investigates whether the ventilation provisions of California's Title 24 building code are sufficient to maintain acceptable IAQ, and whether the requirements could be modified to improve energy efficiency while still maintaining IAQ. Approximately 70 homes in northern and southern California will be instrumented to collect air quality data. In 2016, PG&E completed the installation of test instruments in participating homes. GTI/SoCalGas are scheduled to complete installations in homes located in southern California in 2017. A final report is planned for March 2018.

Class 4 Compressed Natural Gas (CNG) Plug-In Hybrid

Developed and demonstrated a CNG-powered 14,500-pound, Class-4 medium-duty truck with hybrid electric drive. The solution from Efficient Drivetrains, Inc. can improve the fuel economy of a conventional CNG-powered medium duty truck by more than 40 percent. This technology can effectively increase the miles per gasoline gallon equivalent of a baseline.

Near Zero Emission 8.9L Engine Development

Developed the game-changing Cummins Westport "ISL G NZ" engine for medium truck and bus market segments, such as transit and refuse transfer trucks. Exhaust emissions are 90% lower than the current US EPA NOx limit of 0.2 g/bhp-hr. CARB has defined this certified near-zero emissions level of 0.02 g/bhp-hr NOx as equivalent to a 100% battery truck using electricity from a modern combined cycle natural gas power plant. The ISL G NZ also meets the 2017 US EPA GHG emission requirements with a 9% GHG reduction from the current "ISL G" engine.

Near Zero Emission 12L Engine Development

Initiated the development of the Cummins Westport "ISX12 G" natural gas engine. The ISX12 G natural gas engine is a larger-displacement natural gas engine suitable for a variety of heavy-duty vehicles, including regional-haul truck/tractor, vocational, and refuse applications. The near zero ISX12 G exhaust emissions are 90% lower than the current US EPA NOx limit of 0.2 g/bhp-hr. CARB has defined this certified Near Zero emissions level of 0.02 g/bhp-hr NOx as equivalent to a 100% battery truck using electricity from a modern combined cycle natural gas power plant. With a displacement of 11.9 liters and up to 400 hp and 1450 lb-ft. of torque, the ISX12 G is the natural choice when considering alternative fuel for demanding applications.

Gas Operations

Alternating Current (AC) Earth Faults

Earth/ground faults from high power AC sources can damage pipelines and coatings. Project started in late 2016. A predictive model is being developed to show what areas are at risk for the greatest exposure to AC faults. Project deliverable may comprise of a mitigation plan that establishes proper spacing between facilities in a utility right of way.

Pipeline Corrosion Control

A new cathodic protection system may reduce the cost of protecting our steel pipelines in remote locations where utility power is not available. A Solid Oxide Fuel Cell Rectifier was installed in late 2016 at a remote desert location where its performance is being evaluated over a one-year (4-season) period. If proven to be reliable and efficient, it will replace the lower capacity, higher cost thermo-electric generators currently in use.

Intelligent Shutoff Device

Gas pipelines are particularly vulnerable to damage from third party excavators. An intelligent shutoff system has been designed to shutoff gas flow if the system detects the smallest leak from the outer protective casing. A prototype system has been fabricated and successfully tested. The final phase in 2017 will produce 20 systems for an inground 6-month pilot field test.

Leaks from Slow Crack Growth in Polyethylene Pipe

Assess how a leak evolves overtime in plastic pipe due to slow crack growth (SCG) to gain a better understanding of how this contributes to methane emissions from distribution pipelines. Significant progress was made on the design and construction of leak evolution test rig and hardware upgrading of the cyclic pressure tester. Completion of the cyclic pressure tester in early 2017 will allow the creation of SCG in plastic pipe samples.

State-of-the-Art Methane Sensors

Detection and quantification of methane emissions is important for the entire natural gas industry, since methane is a GHG. This project is to investigate the current state-of-the-art in methane “point” sensors and how they are used in the utility industry. A technical assessment of 28 methane detection technologies were performed. A unique sensor chip from BioInspira uses colorimetric analysis to measure specific gases has been selected to be tested in 2017.

Emissions Quantification Validation Protocol

Methane emissions quantification technologies were evaluated in a series of controlled and real-world tests. There is a need for a validation procedure to ensure traceability and reproducibility of measurement data. API 1163 “In-line Inspection Systems Qualification Standard” has been

selected as the model to follow in the development of a formalized validation procedure. Additional field tests will be performed in 2017 to substantiate the validation protocol.

Hydrogen Natural Gas Blend Operational Impacts

The University of Southern California's (USC) Engineering School completed laboratory tests of hydrogen blended gas supplies simulating storage operations. High pressure permeability tests were performed on the impermeable upper layers of rock (caprock) and cement samples. Although hydrogen molecules are small, the study showed that hydrogen molecules did not permeate through the caprock. It is recommended further research is needed to enhance the confidence of USC's initial findings.

Polyethylene Pipe Technology

Quality control inspections of plastic material is critical to ensure material quality and reliable long-term performance. Manual wall thickness measurements of plastic pipe are limited to the pipe ends. However, an ultrasonic testing (UT) gauge can measure along the entire length of a pipe segment. A comparative assessment of a digital UT gauge and the standard micrometer was performed. Results showed the UT gauge can serve as an alternative method to the micrometer for making accurate wall thickness measurements. With proper calibration, the UT gauge readings were within 0.002" of the micrometer measurements.

Low Carbon Resources

Biogas Processing and Upgrading Technology Assessment and R&D Pathways

Completed study to characterize and evaluate biogas conditioning and upgrading technologies that would allow the injection of upgraded biogas into existing natural gas pipelines that meet the requirements of SoCalGas Rule 30 and AB 1900 (2012).[51] Key conclusions were: processes are well established to perform removal of water, hydrogen sulfide, siloxanes, nitrogen, oxygen, and CO_2 from various biogas sources in order to meet gas specifications for pipeline injection.

Demonstration of Digester Gas Fired Engine

The objective of this demonstration was to identify a reliable, cost effective method to achieve SCAQMD Rule 1110.2 compliance using digester gas fuel for engines. In 2015, Tecogen emission control technology was successfully installed on a rich burn engine that runs on digester gas at the Eastern Municipal Water District water treatment facility in Perris, California. The engine and emission control system successfully ran throughout 2016. This project has been completed.

[51] AB 1900 (Gatto, Stats. of 2012) requires the CPUC, in consultation with CARB and the Office of Environmental Health Hazard Assessment (OEHHA) to develop standards for constituents in biogas to protect human health and pipeline integrity and safety.

Solar Thermal Heat Pump - Chromasun

Chromasun completed an evaluation of baseline energy use at the JW Marriot Hotel in Palm Desert in 2014/2015 in preparation to install and monitor this solar thermal demonstration project. Also, final system designs to install the solar system at this hotel were completed in 2015 along with permitting activities with the city of Palm Desert. System installation will be completed in 2016.

Hybrid Solar System

Developed a hybrid solar system that integrates a hybrid solar collector using non-imaging optics and PV components with a heat transfer and storage system using particle laden gas as thermal media to simultaneously generate electricity and high temperature heat. This project was completed in late 2015 and demonstrated a tunable receiver with up to 365°C receiver outlet and about 40% thermal efficiency. Also, no particle degradation was observed with the energy storage media.

Thermal Energy Storage with Supercritical Fluids

Developing a novel and low-cost approach for implementing a thermal energy storage system designed to operate over a wide range of thermal energy storage. The approach employs a patent-pending concept that uses elemental fluids for the storage material.

Renewable Hydrogen and Methane from Solar Thermocatalytic Water Splitting

In collaboration with DoE, University of California, San Diego and Science Applications International Corporation (SAIC), SoCalGas supported the development of a high-temperature sulfur-ammonia solar thermochemical water-splitting cycle to produce renewable hydrogen and methane. Improvements were made to electro-catalysts and a 500-hour durability test was initiated to demonstrate the long-term stability of the electrolytic cell materials. The development team is now preparing for on-sun testing at a concentrating solar dish recently installed at San Diego State Brawley.

Biomethane Purification Demonstration

Demonstrated an advanced state-of-the-art biogas system that was upgraded to pipeline-quality standards. SoCalGas designed and installed a heavily instrumented biogas processing system comprised of pressure swing adsorption (PSA) vessels, activated carbon media and a hydrogen sulfide reactor at a waste water treatment plant in Escondido, CA. Over the 18-month demonstration period, the upgrading system reliably converted highly contaminated, CO_2 rich biogas from the facility's anaerobic digesters into pipeline-quality RG.

Solar Baseload Power Generation using Natural Gas Pipeline

Development of a Power-to-Gas energy storage dynamic simulation model incorporating performance parameters for multiple elements (e.g., start-up time, shut down time, transients

from solar). Concurrently, the National Renewable Energy Laboratory[52] team will design, build and operate a small-scale physical Power-to-Gas system to test the system performance.

[52] National Renewable Energy Laboratory (NREL) is a federal laboratory dedicated to research, development, commercialization, and deployment of renewable energy and energy efficiency technologies.

APPENDIX E
GLOSSARY OF TERMS

AB	Assembly Bill
AQMP	Air Quality Management Plan
BCM	Best Available Control Measure
BY	Base Year
CAA	Clean Air Act
CARB	California Air Resources Board
CC&U	Carbon Capture and Use
CDFA	California Department of Food and Agriculture
CEC	California Energy Commission
CHP	Combined Heat and Power
CNG	Compressed Natural Gas
CO	Carbon Monoxide
COP	Coefficient of Performance
CP	Corrosion Protection
CPUC	California Public Utilities Commission
D.	Decision
DC	Direct Current
DSE	Dynamic Staged Entrainment
DG	Distributed Generation
DOE	Department of Energy
DOGGR	Division of Oil, Gas and Geothermal Resources
E&EP	Energy & Environmental Policy
EA	Environmental Affairs
EOP	Executive Order
EOR	Enhanced Oil Recovery
ERW	Electric Resistance Welded
FCEV	Fuel Cell Electric Vehicle

FOF	Fueling Our Future
FTE	Full-Time Equivalent
GHG	Greenhouse Gas
GRC	General Rate Case
HDV	Heavy Duty Vehicle
HSS	Hybrid Solar System
IAQ	Indoor Air Quality
IEPR	Integrated Energy Policy Report
LCFS	Low Carbon Fuel Standard
NAAQS	National Ambient Air Quality Standards
Ng/joule	Nanograms per Joule
NIOs	Non-Imaging Optics
NOx	Nitrogen Oxides
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
NSS	Non-Shared Services
NZE	Near-Zero Emission
O&M	Operations & Maintenance
OEHHA	Office of Environmental Health Hazard Assessment
OEMs	Original Equipment Manufacturers
OSHA	Occupational Safety and Health Administration
P&ES	Policy & Environmental Solutions
P&LA	Planning & Legislative Analysis
P2G	Power-to-Gas
PE	Polyethylene Pipeline
PHMSA	Pipeline and Hazardous Materials Safety Administration
PM	Particulate Matter
PPM	Parts per Million
PRCI	Pipeline Research Council International
PSA	Pressure Swing Adsorption

PV	Photovoltaic
RD&D	Research, Development, and Demonstration
RECLAIM	Regional Clean Air Incentives Market
RFID	Radio-Frequency Identification
RG	Renewable Gas
SAIC	Science Applications International Corporation
SB	Senate Bill
SCAQMD	South Coast Air Quality Management District
SIP	State Implementation Plan
SJVAPCD	San Joaquin Valley Air Pollution Control District
SLCP	Short-lived Climate Pollutants
SoCalGas	Southern California Gas Company
TCR	The Climate Registry
TDV	Time Dependent Valuation
TRC	Total Resource Cost
TY	Test Year
UAS	Unmanned Aircraft Systems
UCSD	University of California, San Diego
ULN	Ultra-Low NOx
US EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
ZNE	Zero Net Energy