APPENDIX B: QUESTIONS AND ANSWERS FROM JANUARY 25, 2018 STAFF WORKSHOP TO DISCUSS PROPOSED FY 2018-19 NATURAL GAS RESEARCH INITIATIVES

The following is a summary of stakeholder questions and comments submitted orally and in writing, including Energy Commission staff responses.

Industrial Agriculture & Water Efficiency:

Julia Levin: Bioenergy Association of California

Workshop Comment #1:
Strongly support this program area. You don't mention converting agricultural livestock waste to energy as one of the research areas. It seems like there's such an incredible opportunity to reduce short lived climate pollutants from burning of agricultural waste and from livestock methane. It seems like a really important omission that should be corrected. That's a critical funding area to figure out how to convert agricultural and livestock waste to renewable gas that can help replace fossil fuels gas. We really encourage you to add that specifically in this section.

> ***Energy Commission Response:***
> Thank you for your comment. Converting agricultural waste to energy is addressed in the Renewable Energy and Advanced Generation R&D initiatives.

Bud Bebe – California Hydrogen Business Council

Workshop Comment #2:
Clarification if you could, the largest industrial users of natural gas in California are refineries. But, they have a number of other pathways in R&D available to them. How would do you define large industrial users within this particular budget and program? And, if Ms. ten Hope could elaborate more on the split between EPIC and how hydrogen actually could fit within these. Hydrogen has natural applications and natural commercial interests, both in electricity and natural gas, and our application is between the two and not specifically funded. How do you treat refineries relative to this program? And, secondly, how do you view EPIC and this natural gas program, relative to the Hydrogen technology interests?

> ***Energy Commission Response:***
> For the purposes of the natural gas R&D initiatives for energy efficiency, large industrial users are those that must report their CO2 emissions annually to the California Air Resources Board (CARB). Industries/facilities emitting more than 10,000 metric tons of CO2 annually are required to report these emissions to CARB. Those that emit more than 25,000 metric tons annually must reduce emissions or purchase allowances in quarterly auctions. The natural gas, energy efficiency R&D focuses on how to help these industries reduce energy use and CO2 emissions.

Additionally, hydrogen is not explicitly in the EPIC nor the natural gas research initiatives. We are seeking input on this area on future research needs in order to determine where it fits best with EPIC or natural gas R&D and how it could be a strategy for decarbonization of the industrial and other sectors.

In regards to refineries, they are eligible to participate in the program with research projects that meet the requirements of the solicitation.

Chris Savage (WebEx)

Workshop Comment #3:
I would suggest that a meeting with Key Industry Trade Associations would be an important outreach activity to encourage participation. Also, larger awards are better than smaller given the increasing cost of technology.

Energy Commission Response:
We acknowledge and thank you for the comment.

Sara Polgar (WebEx):

Workshop Comment #4:
I did not understand how commercial natural gas efficiency projects were being covered. It seems like there's a hole where these types of projects are not available for funding through EPIC funds, but also might not be available here. If novel cost effective solutions can be demonstrated for small businesses such as restaurants to save substantial natural gas, what is the appropriate way to work with the CEC?

Energy Commission Response:
We have several small efficiency commercial projects that we have done in our portfolio in the past, and there is a good representation over the last few years and currently with several active research projects benefit smaller entities such as restaurants. We would also like to mention for commercially available efficiency technology there are utility programs that are available, so that could be another avenue for exploration.

Department of Energy, Lawrence Berkeley National Laboratory (Email #1)

Comment:
Through research on related natural gas appliances for the Department of Energy (DOE) a group of researchers at LBNL has taken note of and interest in examining potential efficiency opportunities with residential room gravity, wall and floor room furnaces.

The appliance, combustion and procurement researchers here at LBNL urge CEC to at a minimum investigate the population and insitu use of these highly inefficient and dangerous heaters. A small study absolutely needs to be done to test the commonly held assumptions that have heretofore prevented research and subsequent standards development around these

heaters found in residential (probably in low income) and light commercial structures throughout California.

These assumptions that need to be investigated are:

- There are too few of the room gravity heaters (wall and floor mounted) operating in CA.
- The operating hours of these units is very low and the current energy standards that address the pilot light are sufficient energy policies.
- The existing stock of units operate at rated efficiencies in the upper 70% range.

These gravity heaters are very low cost with retail prices ranging from $600-$1,000 depending on Btu/hr and features. Two common brands are Williams Comfort Products and Cozy Heaters Inc.

The research team proposes that the following qualities of these gravity heaters need to be investigated:

1. This class of heating appliances operates in situ at significantly lower than the AFUE rated 69-70% AFUE.
    a. This appliance draws combustion gas from room and thereby removes heated air.
    b. Hot combustion gas rising through chimney (or through wall cavity into vented attics) draws air relieved from room - draft diversion.
    c. The exterior of the heat exchange surfaces collect a large amount of dust and dirt reducing appliances efficiency further.
    d. The combustion chamber and heat exchange surfaces are made from inexpensive sheet steel that corrodes easily reducing heat transfer.

2. According to the Energy Information Agency (EIA), 2009 Residential Energy Consumption Survey (RECS), there is an estimated 900 K to up 1.7 M of such gravity room heaters in CA. This equates to 14% of residential heating appliances in California.
    a. Considering the very low efficiency and relatively large population of gravity room furnaces, they have an outsized affect on residential natural gas use. The vast majority of other heating appliances operated at efficiencies greater than 80% AFUE and draw combustion and flue draft air from sources exterior to building.
    b. This is a significant number of appliances that are not well understood from a performance perspective and therefore lack fundamental data needed to make policy decisions about standards and DSM programs.

3. There is concern that this class of heating appliances may pose serious health and safety risks to residents of California that are as of yet not well understood.

a. During storms or rooms with ventilation fans and or fireplaces, there is concern these changes in air pressure may cause combustion gasses spillage into living spaces.
b. There are a certain number of appliances vented into the attics (by law only into vented attics).
c. Though the causes of home fires caused by heating appliances are collected by NFPA, the data is not granular enough to differentiate between types of heating appliances.
    i. Both floor and wall furnaces have very high surface temperatures which can easily ignite room furnishings (rugs and furniture)

Areas of Possible Research:

1. Establish population, efficiency and emissions data needed for policy makers:
    a. Improving upon RECS data (as needed) to gain greater insight on population and use of this low efficiency heating appliances in residential and light commercial environments in the CA.
    b. Establish baseline efficiency and emissions characteristics by testing in combustion lab, using an established test standard (or one modified to cover this class of appliance) using aged samples taken from residences.
    c. Test and compare aged gravity units against new, out of the box units and those equipped with fans for forced heat circulation.
2. Examine barriers to introducing high efficiency condensing units as a retrofit option to these inefficient room heaters.
    a. Undertake detailed life cycle analysis of existing and replacement options in both new construction and retrofit applications.
    b. Work with flue engineers and manufactures to develop a harness product comprised of a coaxial flue, condensate and power line that can be pulled through existing class B flue pipe that these appliances require. This work to be proposed if a analysis shows that it makes financial, sense to pursue a retrofit approach.
    c. Work with manufacturers (Williams and Cozy for example) to explore the viability of developing a high efficiency appliance that can mount into the cavity of existing unit thereby reducing the cost of replacement.
    d. Analyze the use of demand side management (DSM) programs as a means of inducing retrofit of this low efficiency product.
    e. Investigate IAQ and safety issues at greater depth with this subject appliance.
    f. Provide data and analysis for CA energy policy community to develop appliances standards that address these appliances.
    g. Propose research through the CEC-EPIC program to investigate the financial and technical feasibility of replacing existing units with ductless split systems as a second option to high efficiency natural gas units.

i. Compare/contract the two options from technical, financial and greenhouse gas characteristics.
ii. Examine the currently available line-set, condensate and power harnesses for use in retrofit applications – look at how easily this harness can be pulled through existing flue.
iii. Work with code making committees and manufactures to look at options for condensate disposal.
iv. Investigate number of residences that have electric service large enough to accommodate ductless split heat pump systems.

Energy Commission Response:
The focus of the natural gas energy efficiency research in the 2018-2019 Proposed Budget Plan is on natural gas and GHG emission intensive industries and facilities-primarily those that emit more than 10,000 metric tons of GHG emissions annually. Some of these industries are subject to the Cap & Trade Program and must reduce emissions or purchase allowances in quarterly auctions.

The CPUC in resolutions G-3519 andG-3527 instructed the Energy Commission to focus on research solutions to help industries covered by the Cap-and-Trade program because they are emissions intensive and trade exposed (EITE) and could potentially relocate outside of California.

With respect to the recommendation regarding research on wall and floor heaters, this was an initiative contained in our 2017-18 natural gas budget plan. We are considering this research topic for a future solicitation http://www.energy.ca.gov/contracts/pier.html). Please be sure to sign up for the Energy Commission's Opportunity List Serve to be notified when it is released.

California League of Food Producers (CLFP) (Email #2)
Comment:
CLFP believes one of the paths to achieve the state's long-range environmental goals is through investments that facilitate research into and foster the development of new and innovative technologies that will enable California's food processing industry to meet compliance challenges through increased efficiency.

CLFP believes that markets/industry factors drive these decisions for most industrial food processors. Almost by necessity, companies and facilities are forced into incremental improvements. Overall, incremental projects appear to be easier to schedule, can be timed to avoid conflicts with marketing requirements or production schedules and demands and offer immediate compliance benefits. That said, given California's ambitious environmental goals, it is clear that transformative technologies will be needed to ensure that California industries have, at the least, a modest chance at meeting these targets. CLFP urges the Energy Commission to think outside the box in pursuing transformative technologies. A thorough understanding by CEC

researchers of an industry's needs will aid in the determining which types of transformative technologies offer the most promise.

Energy Commission Response
We will consider your comments as we plan future solicitations. With regard to advanced technologies, we currently have an industrial roadmap underway to help identify specific priority research needs and technologies on the electricity-side that have the most promise for implementation in the near and mid-term. We also have a similar activity on the natural gas side focusing on identifying advanced technologies and strategies to improve performance and reduce energy costs in the food processing industry. Both of these documents can help inform future needed industrial energy efficiency research. In addition, we will consider holding public workshops to inform the industry of the results from these studies, but also to obtain stakeholder input on industry needs and consideration of additional advanced technologies. Examples of on-going research associated with food processing industry can be accessed by searching the Energy Innovation Showcase database: http://innovation.energy.ca.gov/. The Energy Commission has recently created a webpage for a new program called the Food Production Investment Program, which targets energy and greenhouse gas reducing projects for the food processing industry. For more information: http://www.energy.ca.gov/research/fpip/index.html.

Comment:
The current price of natural gas may be low, but it remains an expensive commodity in California due to the enormous costs of transport for industrials. As recently as last year, a CPUC decision more than doubled the cost for the transportation of natural gas. This decision effectively eliminated any benefits that may have been available due to declining commodity costs. Many thermal-based industrial facilities are still trying to deal with this cost increase. Yet, late last year a new proceeding was filed, requesting an additional 30% increase. At this time, CLFP is unsure whether there are any technologies with sufficient promise to offset ever-increasing rates for natural gas. However, the recent Scoping Plan update identifies renewable natural gas as one area that presents promise as an alternative.

CLFP recommends the Commission take a serious look at Renewable Natural Gas as a viable alternative with an eye to development of an infrastructure design that would facilitate increased usage by industrials, possibly stabilize rates, and offer fuel-switching options to industrial users.

Energy Commission Response:
The Energy Commission has been supportive of advancing biogas or biomethane production from various organic wastes including wastewater from food processing industries, food wastes, agricultural residues, including livestock manure, and woody biomass. The Energy Commission has sponsored, both under the Electricity R&D program and Natural Gas R&D program several research projects focused on both biological and thermochemical conversion of organic residues. The goal of this research is to develop and demonstrate new technologies while improving efficiency, reducing costs and reducing environmental impact compared to conventional systems. Recently, there has a focus on

agricultural residues in the Central Valley, so for the 2018-19 plan, a proposed initiative under the Renewable and Advanced Generation will support production of renewable fuel from such residues found in the region.
Past research on biogas projects associated with the food production industry, can be found at the Energy Innovation Showcase: http://innovation.energy.ca.gov/

Comment:
CLFP has noted the effort by the Commission and staff to introduce reforms to program designs and solicitations aimed at streamlining the process for participation by industrials. New requirements should reflect an understanding of the limitations and market pressures of the industry or facility being targeted, for instance, the seasonality issues central to food processors. Additionally, the ability to stack incentives across agency offerings would be key to increasing participation by industrials. Upgrades and retrofits are expensive, and it is absolutely vital that these endeavors pencil out financially.

Energy Commission Response:
We are working with the Emerging Technologies Coordinating Council to identify strategies for including promising research projects into energy utility program offerings. Pacific Gas & Electric Company, San Diego Gas & Electric Company, Southern California Edison Company, and Southern California Gas Company administer the Emerging Technologies program under the auspices of the California Public Utilities Commission. In the past, some demonstration sites participating in our grant program have also received funding or technical assistance from the investor owned utilities (IOUs) through their Emerging Technologies programs. If the IOU funds are in line with the goals and purposes of the Energy Commission R&D program, then the IOU program funds can be used as match funding for our grants. However, Energy Commission R&D funds cannot fund commercially available technologies that have been well established and proven. As the IOUs are planning future programs and activities, it is important to also inform them of your industry needs.

Comment:
Call me. Email me. Drop by my office. CLFP is always open to working with CEC staff and researchers on issues affecting food processors and the food processing industry.

Energy Commission Response:
We appreciate the willingness of CLFP staff to work with Energy Commission staff.

Gallo Glass (Email #3)

Comment:
Gallo Glass Company is a significant stakeholder in California's glass manufacturing industry, and one of just four remaining glass plants in the state. We are a natural gas customer and seek to reduce our natural gas use, as well related greenhouse gas emissions, while remaining competitive in a global market. Programs like the proposed Industrial, Agriculture, and Water Efficiency initiative can provide valuable funding to accomplish this.

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Gallo Gas Company seeks to offer the following comments, particularly as they pertain to the proposed Industrial, Agriculture, and Water Efficiency initiative.

Fewer, yet larger awards would be more impactful on reduction of greenhouse gas (GHG) emissions, and would likely increase program participation across the industrial sector. For many large manufacturing operations, the cost to install energy efficiency projects can be very high --$5 to 10 million+ is not uncommon for an individual project. These larger projects, of course also result in the greatest reduction in natural gas and GHG emissions. We also recognize the inherent risk to the California Energy Commission of awarding fewer, larger awards. To mitigate that risk, we propose that the California Energy Commission offers a tier of funding in FY 2018-2019 that would award funds up to $500,000 for engineering design and review, consultant fees for site planning, and/or costs for related business plans and feasibility studies, which would help to demonstrate the technical merit and benefits of the proposed project. If grant funding supported these efforts now, in future funding rounds, applicants could better demonstrate project results and viability and give the California Energy Commission higher confidence in funding deployment, research, and demonstration project awards at higher levels. Our minimum recommendation would be to increase the grant funding maximum award for these projects from $1.5 to $5 million.

Energy Commission Response:
We appreciate your comments. We believe this is a workable approach and will consider in future solicitations

Comment:
The scoring criteria in previous programs related to spending grant funds in California and the restriction of funding not being allowed to be spent outside the United States puts applicants who seek to invest in innovative and emerging technologies at a disadvantage if the technology is only available from manufacturers outside of California, or the United States. Many, if not most, innovative technologies for Energy Intensive Trade Exposed (EITE) industries like container glass making, come from Europe and other countries. Limiting grant spending only to the U.S. severely hampers a company's ability to take advantage of innovations that come from outside the U.S. This limitation does not allow for a truly global view of the opportunities that may exist to reduce energy use. Gallo Glass recommends that if an applicant can effectively prove that there is no ability to purchase equipment in California or the United States that an exemption is included to allow for grant funding to be spent in this manner.

As it relates to the scoring criteria, Gallo Glass recommends that the applicant receive the full scoring consideration for this section, if they can prove that the technology is not available in California. This would also apply to the California Based Entities Preference Points, allowing applicants who cannot purchase equipment in California to be considered for full scoring points in this section, if their business is located in California. This would better encourage large, manufacturing (i.e. EITE) applicants to participate in the program.

Energy Commission Response:
We appreciate your comments and will consider your suggestions. We need to balance the fact that funds come from California ratepayers and we want to maximize funds spent and benefits in California, but at the same time, we realize that such limitations could hamper opportunities for innovative and transformative research and products.

Comment:
Handling of Confidential Business Information (CBI) should be amended in future grant application forms. We recommend removal of the language, "The application does not contain any confidential information or identify any portion of the application as confidential." There must be an allowance that certain sections of the application will be confidential and not subject to public dissemination. For many, if not most companies, the details of its specific business performance is CBI, as it can provide competitors information that could disadvantage the applicant. Other state and federal grant programs provide a mechanism for this type of confidential information and we believe these CEC grant applications should as well. Without making this change, the program inherently advantages public entities and disadvantages private entities from applying.

Energy Commission Response:
As these are public funds, the application process and research results are considered public information. Our application process does not require financial statements but it does require budget information about the project, such as labor rates, fringe benefits, overhead, etc. This information is public information and subject to public records act request. For any deliverables, we are not interested in obtaining trade secrets, formulations, designs and blueprints of technology, etc. Once the grant is in place, there is a way to request that certain deliverables be held in confidence, but our attorney and executive director make the final determination on regarding whether they should be considered confidential.

SoCalGas (Email #4)
Comment:
The industrial market sector will be interested in both incremental improvement technologies that can contribute to their near term financial and environmental improvement objectives and longer term transformative technologies that can help them achieve California's aggressive greenhouse gas (GHG) and criteria pollutant reduction goals. However, industrial operators will likely be constrained in their investments in higher risk research due to limited research funding and therefore rely on incentives to provide the majority of funds for the development and demonstration of these new technologies.

Energy Commission Response:
We appreciate your comments and will consider your suggestion to include both incremental and transformative technologies.

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Comment:
Commercial food service cooking equipment generally needs to be improved to increase energy efficiency and reduce both GHG and NOx emissions. Current cooking equipment has never been subject to minimum efficiency standards or mandates for control of criteria pollutants such as oxides of nitrogen (NOx) and particulate matter (PM). As a result, most cooking equipment still use older atmospheric type burner technology with uncontrolled NOx levels. In the 2016 South Coast Air Quality Management District (SCAQMD) ozone reduction plan, Control Measure CMB-04: Emission Reductions from Restaurant Burners and Residential Cooking was adopted which sets a goal to reduce NOx emissions by 50% for this category of equipment. Specific NOx emission targets will likely be set in future air district regulations. In addition, Control Measure BCM-01: Further Emission Reductions from Commercial Cooking was adopted to reduce particulates from underfired charbroilers. The CEC should consider research programs to address these new NOx and PM emission reduction goals for commercial food service equipment in SCAQMD.

In addition, the 2016 SCAQMD ozone reduction plan also adopted several other Control Measures to reduce NOx emissions further. CMB-02: Emission Reductions from Replacement with Zero or Near-Zero NOx Appliances in Commercial and Residential Applications will push for the development of zero or near zero NOx emission residential appliances including water heaters and space heaters. The CEC should consider research programs to address the need to reduce NOx from residential appliances below today's current regulations.

Energy Commission Response:
We will consider your suggestions for research to improve energy efficiency of cooking and other appliances while also reducing NOx and PM emissions for food service and residential appliances in future budget plans. For the 2018-19 plan, CPUC resolutions G-3519 andG-3527 instructed the Energy Commission to focus on research solutions to help industries covered by the Cap-and-Trade program because they are emissions intensive and trade exposed (EITE) and could potentially relocate outside of California. As a result, the focus of the 2018/19 year will be on industrial facilities. Future research initiatives could consider food service and other appliances. However, the Energy Commission has funded much research and demonstration on high efficiency food service appliances. The following are examples of current research on appliances and equipment that focus on energy efficiency and NOx emission reductions:

- Demonstration of an ultra-low-NOx burner for a commercial boiler at Mission Linen in Santa Barbara (GTI – PIR-14-004). The burner uses a novel design called dynamic stage entrainment to reduce fuel usage while keeping NOx emissions low. After more than a year of operation, the boiler has shown a nearly 10% annual fuel savings and a NOx emissions reduction of greater than 70% compared to baseline testing. The emissions limits for these types of boilers are 9 ppm NOx corrected to 3% O2.

- Demonstration of various commercial food service appliances that can improve overall cook line efficiency and validate energy savings and use of commercial

kitchen ventilation optimization techniques (Fisher-Nickel – PIR-14-008). The objective is to encourage the kitchen design and food service community to adopt these advanced efficient appliances versus standard commercial kitchen lines. The project also characterizes cooking equipment NOx emissions for the baseline and high efficiency replacement cooking equipment.

- Demonstration of residential gas-fired heat pump water heater (GHPWH) which integrates a small, gas-fired, single-effect, absorption heat pump with a hot water storage tank, resulting in a projected Uniform Energy Factor of 1.30 (GTI – PIR-16-001). The GHPWH is projected to meet the Ultra Low NOx emission requirements set by the South Coast Air Quality Management District's Rule 1121 of 10 ng NOx/J output.

- Development and demonstration of an innovative, low cost gas heat pump for integrated Commercial Hot Water (CHW) and air conditioning at two full service restaurants (GTI – PIR-16-004). The commercial restaurant industry typically has large hot water loads, and greater internal heat gain from occupancy and kitchen equipment. The project seeks to demonstrate 40% therms savings and offset 20% or more of the annual air conditioning cost.

Comment:
Past CEC research has been successful in getting industrial customers to participate in demonstration of new gas technologies. Several ongoing demonstrations include the following: demonstration of the ribbon burner technology at Western Bagel, demonstration of an advanced industrial dryer at Martin Feed, demonstration of an advanced burner/boiler technology at Mission Linen (in Santa Barbara), and demonstration of an advanced heat recovery technology at Mission Linen (in Oxnard). However, providing more time for applicants to respond to CEC solicitations will improve industrial customer participation. Currently, the short time schedules provided in CEC solicitations are not adequate for many potential industrial host sites to fully investigate/explore their interest in joining demonstration projects.

Energy Commission Response:
Most of our applications are typically due six to eight weeks after solicitation release and we realize that by extending the application period, recipients could minimize the need for future demonstration site changes. In some recent solicitations, we have extended the application period to provide ample time to secure demonstration projects. The Energy Commission is also proposing to the CPUC consideration of a three year funding cycle, similar to EPIC, and this could result in more time for the application period.

Comment:
CEC research programs greatly benefit from close collaboration with California Independently Owned Utilities (IOUs) in identifying industrial / commercial host sites for technology demonstration projects. SoCalGas maintains an active staff of Account Executives that call on all larger industrial customers. These personal relationships, between SoCalGas and our industrial

clients, provide an excellent way to communicate and acquire participation in research demonstration projects.

Energy Commission Response:
We appreciate this coordination with your industrial clients.

Comment:
The CEC should consider providing more time for applicants to respond to CEC solicitations to improve industrial customer participation. Currently, the short time schedules provided in CEC solicitations are not adequate for many potential industrial host sites to fully investigate /explore their interest in joining demonstration projects. In addition, the CEC should review their current policies on approval of modifications to accepted proposals. Typically, the projects at these large and complex industrial facilities are themselves large and complex, requiring significant planning and engineering. Through that process, identifying new information and obstacles is more the rule than the exception, so the ability to nimbly adapt is valuable for the sake of progress. However, under current CEC project funding practices, changes to a proposal more often require a formal CEC review with Board approval that can take up to one year. This, along with formidable accounting requirements, can discourage some parties from applying for funding. Whatever process CEC can bring into place to reduce the time to review and approve necessary project changes and simplify accounting requirements could increase the number of projects proposed and the number of interested, qualified lead investigators.

Energy Commission Response:
See previous comment regarding expanding the application period. With respect to amendments, we have streamlined the approval process for requesting amendments. For instance, many amendments can now be handled either at the R&D Deputy Director level or below. This should result in quicker approvals of amendments.

Comment:
CEC should consider funding follow-on demonstration projects to further validate new technologies and to assist with early commercialization efforts. Typically, advanced burner technologies may be applied to many different industrial equipment and funding demonstrations in multiple applications can help manufacturers expand their sales potential into many markets.

Energy Commission Response:
Under the Energy Commission's proposed expansion, we have considered an initiative called BRIDGE (Bringing Rapid Innovation Development to Green Energy), which provides follow-on funding for projects with technical and economic promise that could benefit from additional funding to expand and deploy. This Bridge initiative will be similar to the one occurring on the EPIC program. Refer to GFO-17-308: http://www.energy.ca.gov/contracts/epic.html#GFO-17-308.

Comment:
Past CEC research awards in the $750,000 to $2,000,000 range have been adequate to support the majority of new technology demonstration projects. Larger awards, in the $3 to 6 million range, would probably be of interest to large industrial operators, like refineries and power plants, to help fund some of their facility improvement projects.

> ***Energy Commission Response:***
> We will consider your comment.

Comment:
Technology adoption could be improved by funding incentive programs to promote the purchase of new equipment /technologies by early adopters. In addition, funding support of multiple demonstrations of new technologies can provide operators with additional confidence that a new technology will work well at their facility. Finally, funding for longer term M&V of the installed technology to answer potential users' questions of technology longevity and ability to integrate into industrial processes may help in longer term and wider spread adoption of the technology.

> ***Energy Commission Response***
> Funding for multiple demonstrations was discussed previously regarding participation in the BRIDGE solicitations. Though longer measurement and verification (M&V) periods are desirable to ensure sustainability and persistence of savings, often we are limited by the liquidation date for the research funds and cannot extend agreements beyond that date. The typical term is less than four years.

Renewable Energy and Advanced Generation Research Initiatives:

Julia Levin: Bioenergy Association of California

Workshop Comment #5:
It goes without saying we strongly, strongly support this research area, and I think you are asking the right questions, but this is far, far too little funding to begin answering most of these questions. If you think about the gas sector as a three legged stool, one leg is gas safety and improving that, one leg is increasing efficiency, and the third leg is increasing renewable gas to displace fossil fuel gas over time. The third leg is getting really short shrift. In this strategy you're only allocating one eighth of all the dollars to the third leg of the stool. This particular area, renewable gas, is also absolutely central to achieving the requirements of SB1383. I don't see any way to do that with just three million dollars. Part of the reason I was asking earlier about why the agricultural waste energy isn't included in the agricultural section is, we strongly support the inclusion of forest biomass and ag/livestock waste in this section, but then you have left out the entire urban waste stream. Which right now is focused on anaerobic digestion but according to CalRecycle, the vast majority of the organic landfill waste stream is non-digestible organic; it's wood waste it's construction debris, it's the 8 thousand structures in the wine country that

partially burned. And, now all of this waste is going to go to landfill instead of energy facilities, for a whole number of reasons, one being we haven't figured out gasification yet in this state.

Energy Commission Response:
Thank you for your input. We will take that into consideration as we move forward with opportunities to produce renewable natural gas R&D from California biomass sources.

Regarding your comment on the funding amount relative to the effort needed to achieve the SB 1383, when proposing the research initiatives and funding levels, Energy Commission staff considers other State and local funding programs positioned to yield short-term reductions in short-lived climate pollutants. The allocation for Renewable and Advanced Generation is consistent with prior years.

Karen Mills – California Farm Bureau Federation

Workshop Comment #6:
Julia made some really good points and appreciate her comments. I have questions related to the biomass projects. The woody biomass project has become a problem over the years. As you pointed out with many biomass closures; The project that is being conducted at UCSD and the results from that, so how do you tie what you are seeing there - and adding onto the projects right now - are there lessons you'll be able to build from that will make the woody biomass project successful and feasible?

Energy Commission Response:
Thank you for your comment. That project in particular with UCSD helping develop technology for converting woody biomass to methane, it is currently at an early stage research using small bench scale system. We are also supporting development of another small gas conversion technology in Berkeley. We are keeping track of the results and lessons from these R&D projects to support building successful commercial scale systems in the future.

Bloom Energy (Email #5)

Comment:
Bloom supports the research initiative addressing *Improved Functionality and Readiness of Advanced Distributed Generators for Fire Risk Regions and Critical Facilities*. We particularly agree with the language as written on slide 35 showing that the scope includes both natural gas and biogas fueled systems (e.g. *"clean and efficient distributed generation, including biogas-fueled systems"*). Additionally, the stated goals of this program *include "Developing hybrid, fuel-flexible, energy efficient, and low emission DG technologies for natural gas and alternative fuels including biogas."* Because the alternative to advanced distributed generation systems at critical facilities and in remote areas would most often be diesel or propane fired generators, both RNG fueled and natural gas fueled clean and efficient advanced distributed generation with superior functionalities that would obviate the need to use them would confer environmental benefit. These benefits would be further enhanced by using a non-combustion technology such as a fuel

cell that has near-zero emissions of criteria pollutants and particulate matter. We request that the rest of the language describing this research initiative, including the questions posed and answered below, reflects this fuel diversity.

Energy Commission Response:
The Energy Commission acknowledges the importance of fuel diversity, and has crafted the initiative language to include both natural gas and biogas as eligible fuels for this initiative.

Comment:
One of the most important functionalities that would address the needs of fire risk regions and critical facilities is the ability to grid island and continue to serve onsite load in the event that the electrical grid goes down for extended periods, whether from damage or from proactive shut off such as de-energizing a circuit during high wind events to avoid the ignition or spread of wildfire. Among many other things, access to electricity is important for communications infrastructure that first responders and citizens rely on for accurate safety information, for shelters and community centers where affected communities can congregate and find food, water, and other essential resources, and for hospitals to continue serving their communities. A clean advanced generation system (defined as a system that lowers GHGs, lowers criteria air pollutants, or both) that could supply continuous power while the grid is down for extended periods would ensure that these facilities are operational and continue to provide their essential services. Utilization of either natural gas or biogas in advanced technologies would provide significant benefit so long as the technology is proven to exceed the efficiencies of the technologies it is displacing.

Grid islanding capability for extended periods of time is also an important resource for grid operators. Knowing that there are critical facilities that continue to have power, where those facilities are, and how long they can continue to operate without grid service can relieve constraints on the logistical challenge of getting a regional grid back up and running, leading to faster restoration of service.

Energy Commission Response:
The Energy Commission also acknowledges the importance of grid islanding capability. As with previous research plans, it is worth noting that the research initiative does not present an all-inclusive list of features and technologies that may be funded. Instead, examples of possible technologies and strategies that could be funded are provided. The Energy Commission will consider including grid islanding capability as one of the desired "advanced functionalities" when the solicitation is released.

Comment:
Having an onsite fueled DG resource is ideal when there is a requirement for a relatively large amount of power (more than 50 kW) and/or for a long duration (more than a few hours). If a facility wants to ensure an electricity supply for extended durations, relying solely on storage that is storing grid electricity and cannot recharge while the grid is down is not a tenable solution. Clean fueled DG resources, especially those that are connected to the natural gas system and can therefore have a long duration and a high reliability fuel supply, are a better solution.

Energy Commission Response:
The Energy Commission acknowledges that there are certain advantages of natural gas-fueled DG systems over energy storage, especially when considering long duration reliability. However, there are disadvantages and trade-offs as well. These trade-offs are expected to be explored as we develop this research initiative into a solicitation.

Comment:
Storage operating in concert with fueled DG systems can serve facilities with complex load curves (e.g. with variable peaks of demand) where the fueled resource can serve a baseload function while storage serves the peaks. If the storage is configured to charge from the fueled DG resource while the grid is not operational, then this will be possible for extended durations as well. If the storage does not charge from the DG resource, then the ability to serve peaks will only last as long as there is remaining grid electricity stored.

Energy Commission Response:
The Energy Commission acknowledges the ability of DG and energy storage to operate together better to serve facilities with complex load curves. The Energy Commission expects and encourages projects proposed under this initiative to include energy storage along with DG, though it does not expect this to be a strict requirement.

Comment:
While this question is addressing the *Central Valley Agricultural Waste Resource to Energy* research initiative, it is applicable to developing advanced distributed generation for critical facilities in the Central Valley as well. Put simply, electricity generation technologies that have near-zero emissions of criteria air pollutants and particulate matter would have significant impact on improving local air quality. The electricity can serve a variety of onsite loads without air pollution dispersing into local communities, can displace the need for generation from centralized gas plants in the Central Valley thereby reducing basin air pollution, and can support electrification efforts in the transportation sector to eliminate emissions from mobile sources.

Energy Commission Response:
Regarding air quality in the central valley, the Energy Commission acknowledges the potential contribution that clean and efficient distributed generators could have on improving air quality. However, as stated in the Central Valley initiative, projects are expected to demonstrate a “whole system approach” from feedstock to end use. A system utilizing fuel cells for power generation could be eligible, but only if the feedstock to power said fuel cell is sourced from central valley farm biomass resources.

SoCalGas (Email #4)

***Comment*:**
The CEC plan identifies thermal storage and utilization as an enabling technology for increased micro-combined heat and power (MCHP) development. While this is certainly helpful, it has been our experience that the complete lack of MCHP product options is due to difficulties meeting

emissions standards. These standards, in the case of MCHP, are not local air district standards but are statewide California Air Resources Board (CARB) Distributed Generation (DG) standards. SoCalGas has been instrumental in conducting outreach to MCHP vendors worldwide, collaborating with entities such as GTI, and has tested MCHP products at SoCalGas labs. Furthermore, the CEC plan does not address MCHP in residential markets. We have done outreach with several multifamily builders and have found that they are completely unfamiliar with MCHP. SoCalGas has also been engaged in product testing for MCHP at single-family residential scale, testing a 1.5 kilowatt (kW) fuel cell with thousands of installations in Europe at the University of California, Irvine.

SoCalGas has a long history of successful collaboration with the CEC and is very active in supporting CEC solicitations with a variety of activities including; outreach to potential applicants to increase the depth and breadth of applications, co-funding and supporting applications, and outreach to SoCalGas customers in order to locate ideal demonstration sites. GFO-17-501 is a great example of this; SoCalGas supported and co-funded all awardees in Group 3: 'Develop and Demonstrate Near-Zero Emission Small and Micro-Scale Distributed Generation Systems'. All three products to be demonstrated have been involved with SoCalGas for years, two of the products have been tested by SoCalGas, and SoCalGas will host one of the demonstrations.

> ***Energy Commission Response:***
> The Energy Commission appreciates and acknowledges the comments and suggestions provided by SoCalGas, and looks forward to continued support. Staff appreciates the range of suggested research topics in the area of renewable and advanced generation. While staff find them interesting and needed, funding availability will limit us to specific priority areas.

Natural Gas Infrastructure Safety & Integrity:

Steve Golan – U.S. DOE Lawrence Livermore National Laboratory
(Advanced Energy Technology Program)

Workshop Comment #7:
You talk about understanding mechanical failure and preventing mechanical failure, sort of on the basic science and emerging research is understanding materials and how they fatigue and age, and also new technology that actually provide reporting information about its state. Need to understand how materials fatigue and fade and consider research on understanding how materials can report their state in regards to corrosion, etc. Is there possible moving forward going this direction where they automatically report their state?

> ***Energy Commission Response:***
> We would be open to these ideas so if you could write it down in your comments that would be great.

APPENDIX B: QUESTIONS AND ANSWERS FROM JANUARY 25, 2018 STAFF WORKSHOP TO DISCUSS PROPOSED FY 2018-19 NATURAL GAS RESEARCH INITIATIVES

Karen Mills – California Farm Bureau Federation

Workshop Comment #8:
I want to follow up on some of the comments that Todd made as well as growing food in California. Farmers sustain a great deal of energy infrastructure on their land that they have to operate around the sensors that you talked about. The equipment was real intriguing to me obviously seeing everyone's space and operating around natural gas lines, and then identifying the depth. So as you peruse some of these and the research opportunities with new technology for the sensors, and find a tool or methodology that allows a better identification for the depth of these. So the accuracy of this technology would be very helpful for the safety of people.

> ***Energy Commission Response:***
> Thank you. We agree that the depth is something that we need to capture.

Mark Bishoff – Lorax Systems (WebEx):

Workshop Comment #9:
We have been working with the Gas Technology Institute in Chicago for a number of years and we now have two technologies that we are testing at GTI for the purpose of dealing with third party damage. Backhoes are certainly a part of that but there are many means to third party damage when it comes to from distribution, transmission, and service lines. And this technology has been advanced over the last four years, and now in the third quarter of this year this technology should be available for the utilities to look at and investigate. When this technology is activated, it shuts off the flow gas to very low pressure to very high pressures.

> ***Energy Commission Response:***
> Thank you for your comment. We invite you to send information to us so we can look at your technology.

Southern California Contractors Association (Email #6)

Comment:
The Southern California Contractors Association (SCCA), supports the "Natural Gas Infrastructure Safety & Integrity" research and development efforts proposed for 2018-19. SCCA is an all-union association of engineering contractors primarily located in the Southern California region. They primarily engage in construction activities that cause them to interact with existing underground infrastructure.

As you know, great risk exists for contractors and others that excavate around any underground infrastructure, especially high-pressure natural gas lines. The research the commission conducts supports SCCA's goal of increasing the safety of working around this infrastructure.

SCCA members have vast experience in working below the surface. One of the biggest concerns they share is the inability to adequately identify the depth of the infrastructure even

after the utilities have identified their location. The depth of the infrastructure may be required in regulations, but there is no guarantee. Developing some device to positively identify underground utilities, especially high-pressure natural gas lines, would be an excellent use of R&D resources.

I thank you for the opportunity to address you at the workshop and I am committed to further working with the commission to provide the excavator's perspective.

Energy Commission Response:
The Energy Commission agrees that inexpensive sensors (either fixed or portable) to identify natural gas lines is valuable and is an element of the planned research.

SoCalGas (Email #4)

Comment:
We agree the CEC's current portfolio and proposed funding initiatives are addressing key safety and integrity objectives. We recommend revising the goals to specifically reference the enhancement of "system integrity". Concerning the most critical area of pipeline safety and excavation damage prevention one additional area of work could be in the area of preventing pipeline damage on private property where "One Call" requirements are not mandated and where system damages frequently occur.

Energy Commission Response:
The Energy Commission agrees that integrity is fundamental to system safety and captures this in the proposed budget plan. Our slide has been update to specify "system integrity".

SoCalGas routinely leverages the collaboration funding mechanisms achieved through participation in research and development consortiums, such as the Pipeline Research Council International (PRCI), NYSEARCH, and the Operations Technology Development (OTD) organizations. These consortiums provide opportunities to gain synergies in research efforts with other utilities across the nation and benefit from learning of initiatives from members in other states or other countries. These organizations routinely partner with academics and industrial partners to perform a wide variety of RD&D projects. This approach helps to provide a greater diversity of ideas and solutions to improve the possibility for success.

Energy Commission Response:
The Energy Commission appreciates the additional suggestions for growing the research community.

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Energy – Related Environmental Research:

David Huang – California Public Utilities Commission

Workshop Comment #10:
I noticed that in the central valley agricultural waste resources to energy initiative, there was a bullet that stated that the technology should focus on maximizing energy and air quality, and I was wondering how would this build on the current research being done that is being described by Mr. Hou. Is there an opportunity to build off or leverage findings from agricultural initiative and environmental GHG measuring initiative for RNG projects?

> ***Energy Commission Response:***
> We do have a small handful of small gas fires that we can build on, on our upcoming initiative. So, we do have some cooperation there.

Bud Beebe – CA Hydrogen Business Council

Workshop Comment #11:
I think out of necessity these programs will be measuring emissions to sort of understand the larger term and looking at air emissions typically. Now the biomass projects have such tremendous capability to reduce other environmental effects that currently occur in agricultural areas. I think this tends to get swallowed when we concentrate just on looking say at short term greenhouse gas. That's a good thing to think about, and we need the Energy Commission to have good public information available. But it would be wonderful if in all of these, that these projects have greater environmental enhancement capabilities. Instead of just talking about specific emissions or emissions alone, it would be beneficial to mention these projects have much greater environmental impacts and benefits. It would also be helpful to have multi-agency coordination for emission, water benefits, etc.

> ***Energy Commission Response:***
> The CEC definitely agrees that a lot of those projects have many great benefits. For us, an accurate measurement of emissions before and after will be better.

Bloom Energy (Email #5)

Comment:
As evidenced by the passage of AB 398 and AB 617, ensuring that all communities achieve high air quality is a priority of the State and should be incorporated into research considering the development and end uses of renewable natural gas. This principle complements seeking out low carbon solutions to achieve our environmental goals as well as clearly prioritizes maintaining public health and equity. The air pollutant analyses should at minimum include NOx, SOx, and particulate matter.

Additionally, while the stated main objective is *"to measure overall emissions and compare them with estimates to better quantify the benefits from RNG projects,"* we encourage the Commission to include a broader study of the potential for emissions impacts from RNG projects within the scope of this research initiative. Specifically, this initiative should include examining and comparing emissions impacts of various end uses of the RNG, such as combustion in mobile engines for transportation, combustion in stationary engines for electricity generation, and non-combustion electricity generation in a fuel cell. This understanding will complement the analysis comparing public health impacts of combusting upgraded RNG versus natural gas that is also mentioned in this initiative.

Taken together, this information will provide policy makers with a more robust basis for making sound decisions that will lead to the greatest environmental and public health impacts as the RNG supply increases and more RNG projects develop over the coming years.

> ***Energy Commission Response:***
> Criteria air pollutants such as NOx, SOx, VOCs, and PM will be considered. However, depending on the specific site and application, perhaps not all of them will be measured. As discussed in the workshop presentation, the Energy Commission plans to conduct additional research based on the preliminary results from a current project (PIR-13-001) to further investigate the public health implications from combusting RNG versus petroleum natural gas.

Research and development of carbon capture strategies and technologies closely ties into the Energy Related Environmental Research program goal to *"explore how new energy applications and products can solve/mitigate environmental problems."*

Innovative approaches to separating and capturing CO_2 from exhaust streams of gas-fueled technologies have the potential to significantly reduce GHG emissions from the use of natural gas and provide a pathway to negative emissions when coupled with the use of renewable natural gas. We encourage the Commission to include the development of carbon capture approaches in its plans to mitigate the environmental impacts of fuel use, specifically with respect to advanced distributed generation technologies. This focus on distributed technologies complements the initiative within the Renewable Energy and Advanced Generation program to *Improve the Functionality of Advanced Distributed Generators for Fire Risk Regions and Critical Facilities*. The parallel development of these two initiatives would increase the probability that technologies that are developed for critical infrastructure could adapt and incorporate this environmental capability as it matures and becomes widely available.

> ***Energy Commission Response:***
> Carbon Capture and Sequestration using flue gases from natural gas combustion is a very expensive research area that has been traditionally supported by the U.S. Department of Energy. If additional funds become available to the Natural Gas Research Program, the Energy Commission may explore the feasibility of supporting this type of research and demonstration. Potential environmental impacts such as induced seismicity may also be explored.

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Bluefield (Email #7)

Comment:
The natural gas sector must continue to innovate and evolve if it is to play a positive role in achieving California's climate change goals. To this end, we are pleased to see the Energy Commission presenting such a strong, multifaceted agenda for the Natural Gas R&D Program, as well as a proposal to expand funding further for this important work.

Ensuring the success of this agenda will require leveraging the latest innovative technology developments. In particular, the Commission should seek to incorporate new solutions emerging from the intersection of energy, big data, and the revolution in low-cost microsatellites.

There are clear synergies between Bluefield's sensor development and the Commission's proposed 2018-2019 research agenda, and we hope to find ways to participate. Previous grants by the Commission to NASA/JPL for research conducted with their Airborne Visible InfraRed Imaging Spectrometer – Next Generation (AVIRIS-NG) establish a strong precedent, and we hope that upcoming research solicitations continue to incorporate emerging technologies.

There may also be an opportunity for Bluefield to contribute to the Natural Gas Infrastructure Safety and Integrity area, as part of the proposed "Developing Sensors for Pipeline and Storage Damage Prevention" project. Our sensor could complement stationary sensor approaches by detecting pipeline and storage infrastructure leaks from an aerial platform, potentially offering more comprehensive geographic coverage at a far lower cost. In collaboration with utilities, this initiative could utilize our data in combination with other data streams to develop improved analytics for predicting infrastructure integrity issues.

> ***Energy Commission Response:***
> The Energy Commission has funded several different methane emission measurement methods and will continue to support research to reduce methane emissions from California's natural gas system. The Energy Commission will also continue to monitor the technology development in this field and ensure the best science is used to reach the State's environmental goals. If additional funds become available for the Natural Gas Research Program, the Energy Commission may explore the feasibility of supporting this type of research.

Healthy Building Research (Email #8)

Comment:
I noticed that IAQ & ventilation was on the agenda for the Jan. 25 workshop, but I did not see that topic addressed in presentations. What are the status and plans for those projects?

Energy Commission Response:
The Energy Commission has several active research projects funded through both the EPIC and Natural Gas research programs (EPC-15-003, EPC-15-037, PIR-14-007, and PIR-16-012). In last year's workshop, one IAQ project was highlighted in the presentation (500-09-042). The final report for that project has been posted (http://www.energy.ca.gov/2017publications/CEC-500-2017-034/CEC-500-2017-034.pdf). IAQ research remains one of the important topics in environmental related research. The Commission will continue to support research in this area.

Natural Gas – Related Transportation Research

Julia Levin - Bioenergy Association of California

Workshop Comment #12:
Would like the California Energy Commission to consider one small addition of renewable gas to natural gas for transportation use on a larger scale.

Energy Commission Response:
We agree that this is an area we should look at.

SoCalGas (Email #4)

Comment:
SoCalGas agrees that the California Energy Commission (CEC) is prioritizing the right initiatives to advance the science of natural gas-related transportation technologies. During the workshop held on January 25, 2018, the proposed initiatives for Natural Gas-Related Transportation Research included the following:

- Develop High Efficiency, Low Emission, Production-Ready Natural Gas Engines for Long Haul Applications
- Research Natural Gas Compression Ignition to Achieve Comparable Performance to Diesel

These two areas are critical in the development and advancement of natural gas-related transportation technologies. SoCalGas has had a long relationship with the CEC in developing natural gas-related transportation technologies and has been greatly successful with the development and commercialization of the Cummins Westport, Inc. (CWI) 8.9L and 12L near-zero emission engines. It is well known that natural gas engines are relatively 10-20% less efficient than their diesel counterparts, but make up for it with lower NOx emissions, more than 90% cleaner with near-zero emission engines. SoCalGas feels that it is necessary for the CEC to prioritize these two areas, but emphasize more on achieving comparable performance to diesel. Natural gas vehicles have been proven to emit lower NOx emissions and with the combination of

RNG, can further reduce GHG emissions thus achieving California's air and climate quality goals faster. SoCalGas can encourage natural gas technologies directly to its customers and increase the commitment from fleets and truck operators to transition to natural gas and achieve California's air and climate goals.

Energy Commission Response:
The Energy Commission thanks SoCalGas for supporting the development of the now commercialized near-zero emission engines and continuing to support the two proposed FY2018-2019 research initiatives. The proposed initiative on "Research Natural Gas Compression Ignition to Achieve Comparable Performance to Diesel" responds to the need to continuously improve the performance of natural gas engines while maintaining low NOx emissions.

Comment:
Research in engine design and new materials for catalysts would greatly benefit natural gas vehicles. Current natural gas engines have started out as diesel engines that have been recalibrated and re-engineered to run on natural gas. It would be of interest to investigate an engine built specifically for natural gas that takes into consideration the thermodynamics and mechanics of an engine operating on natural gas. Other areas to take into consideration are to promote more manufacturers to produce and commercialize near-zero emission engines.

Currently only one OEM offers a near-zero emission natural gas engine, CWI. In-order to increase economics and growth of the technology, competition is a necessity. SoCalGas is fully engaged in the transportation industry and close relationships with industry partners to help facilitate these technologies.

Energy Commission Response:
Developing an engine built specifically for natural gas as opposed to a re-engineered diesel engine would be of great interest due to the potential for optimizing around the unique properties of natural gas. However, this will require significant investment to achieve a commercial product. Advanced catalyst research may be needed to pair with high efficiency, low temperature combustion technologies to maintain near-zero emissions. The Energy Commission agrees that increased market competition would be beneficial to the continued improvement of natural gas engine technology. The proposed research initiatives will aim to expand the natural gas engine market and develop innovative methods for achieving comparable performance to diesel engines.

Comment:
The CEC should consider areas of research in improving natural gas vehicle infrastructure, cost effective on-board natural gas storage, improve compression efficiencies, and near-zero emission technologies in medium-duty applications. Also, the tri-generation concept where the goal of the system is to reduce the overall carbon intensity in transportation and not limiting or favoring one fuel over the other. The concept of the tri-generation station is to provide transportation fueling infrastructure for compressed natural gas (CNG), Electric, and Hydrogen vehicles at one location.

The Tri-generation system is a fuel cell system, fueled from RNG that will simultaneously produce electricity, heat, and hydrogen fuel. The electricity produced will be utilized for the electrical loads for a CNG and a hydrogen station (e.g., compressors, dispensers, etc.), electric vehicle fast charging (Level 2 and above), electric power to surrounding facilities and excess electricity will be directed back to the grid. Battery storage will also be utilized to help capture the electricity needed for peaks in electricity consumption during compressor ramp up and electric vehicle charging peaks during electric fast charging.

Battery storage will act as a buffer and peak shaving to reduce peak demand during high usage times.

The hydrogen produced will be utilized to support a hydrogen fueling station serving fuel cell vehicles around the area. Excess hydrogen will be sold/sent to industries with high demand of hydrogen or delivered to other surrounding hydrogen stations.

Since the system primarily runs on RNG, the system can also use natural gas to sustain a consistent fuel flow in case of any disruption in RNG availability or quality. In addition, since power is produced from renewable sources (RNG) greenhouse gas emissions are substantially reduced. Using alternative fuels in transportation such as CNG, electricity, and hydrogen fuel cell also reduces NOx, GHG, and PM emissions in the South Coast Air Basin. Transportation technologies are rapidly changing and so should the infrastructure that supports the technologies.

> ***Energy Commission Response:***
> Natural gas fueling infrastructure efficiency and costly on-board storage are important barriers to the adoption of natural gas vehicles. The Energy Commission has previously funded natural gas infrastructure and on-board storage research projects and will consider continued research in this important area. Past and ongoing projects focused on improving the full-fill performance of CNG fast-fill dispensers and low-pressure adsorbed natural gas storage technology. Continued research in this area will be considered in future initiatives.
>
> The tri-generation fueling system is an interesting concept with potential to reduce the overall carbon intensity of several alternative fuel pathways. The Energy Commission will consider this technology concept in the proposed Natural Gas R&D Program expansion, which may include hydrogen and fuel cell-related research.

Comment:
Technology barriers to expand natural gas use in off-road applications are similar to on- road applications. There is a need to achieve diesel like performance as well as larger displacement engines. However, off-road applications require very different engine specifications and duty cycles that need to be closely investigated for natural gas to be successful. Off-road applications span from yard hostlers to construction vehicles to agriculture. These applications typically have higher loads, rough terrain, and long idle times. These barriers include achieving comparable performance and efficiency as diesel engines for higher displacement engines. Technology barriers for off-road applications are not limited to vehicle technologies. Infrastructure for off-road

applications needs to be developed as well. Since most of these applications are relatively further away from any known infrastructure, cost effective and efficient infrastructure needs to be expanded for off-road applications. These might include mobile refueling stations or more efficient drive systems to accommodate long idle times like CNG-hybrid.

For locomotive and marine applications, the CEC should consider advancements in fuel storage and infrastructure needed for these bigger applications.

Energy Commission Response:
The Energy Commission agrees that off-road vehicles have unique duty cycles and engine specifications that require specialized engine development work to ensure comparable performance to diesel. The Energy Commission is currently funding a project with Terzo Power Systems, LLC to develop a highly efficient CNG-hybrid agricultural vehicle that may alleviate some barriers related to infrastructure and extended idle times. The Energy Commission will also consider future research on advancing fuel storage and fueling infrastructure technologies needed for off-road applications.

Comment:
SoCalGas is committed to advancing and expanding natural gas transportation technologies. The SoCalGas Research, Development and Demonstration (RD&D) portfolio for clean transportation and the CEC research initiatives for natural gas transportation technologies complement each other and are imperative for the success and forward progress of natural gas transportation technologies. SoCalGas has a strong history of partnering with and leveraging funding from state and local agencies as well as federal agencies such as the Department of Energy. Most of these technologies center around engine and vehicle development, where SoCalGas' RD&D and natural gas vehicle (NGV) program has built close relationships with key industry partners to advance areas of research and development along with consumer exposure. However, other areas of SoCalGas' RD&D program are to investigate improved infrastructure and alternative ways where natural gas is used for transportation.

Areas that require more emphasis include achieving comparable performance to diesel. This is an area where natural gas technologies are lacking and needs more development. Closing the 10-20% gap on engine efficiency when compared to diesel should be the first and foremost development effort. As the transportation environment transforms, it is important that natural gas technologies to remain competitive and operate analogous to its counterparts. Another area of emphasis is infrastructure. Infrastructure is still a significant barrier for natural gas transportation as fueling stations are not widely available or easily accessible. Without a growing infrastructure, it would be very difficult for fleets and operators to adopt the technology. Emphasis on lower cost and more efficient infrastructure would help encourage the adoption of natural gas.

Energy Commission Response:
The Energy Commission will continue collaborating with SoCalGas's RD&D program to pursue the advancement of natural gas transportation technologies. Improving engine efficiency and competitiveness is a high priority and will be addressed with the proposed

research initiatives. The Energy Commission will consider emphasizing research on fueling infrastructure technology to reduce the cost of station deployment and operation in future initiatives.

Comment:
Collaboration and synergies would include research institutes, national labs, technology manufacturers and provides, other governmental agencies, private manufacturers and IOU's.

Continued collaboration is required for the advancement of the technologies, but should not be limited to similar projects.

Energy Commission Response:
The Energy Commission will continue to collaborate with research institutes, national labs, technology manufacturers and providers, other government agencies, private manufacturers, and IOUs to ensure the successful advancement of natural gas transportation technologies.

Comment:
SoCalGas is also focused on reducing both criteria pollutants and GHG's by way of both efficiency improvements and emissions control technologies. We do so in a technology neutral fashion as there are still improvements to be made on technologies that have reached maturity. An example of this would be our work with the company Tecogen, developing an advanced catalyst system which reduces NOx and carbon monoxide (CO) to near zero levels and can be retrofitted onto existing engines.

Lastly, the CEC should add to their list of policy drivers shown on slides 11, 12, and 13, the need to help the various air districts in CA to meet the Federal Clean Air Act Ozone Standard and the need to substantially reduce NOx (a precursor to Ozone) by 50 to 70%.

Energy Commission Response:
Slide 13 has been revised to explicitly mention the need to meet federal health-based air quality standards for ozone and particulate matter. This is one of the critical goals identified in the 2016 Mobile Source Strategy. The Energy Commission's natural gas-related transportation research will continue to focus on advancing near-zero emission technology that can help California's air districts meet these air quality goals.

University of California, Irvine: Advanced Power & Energy Program (APEP) (Email #9)

Comment:
We are writing to address comments made by workshop participants suggesting that renewable natural gas (RNG) use in heavy-duty vehicle (HDV) applications receive a research focus. Specifically, we are responding to comments made by the California Bioenergy Association (CBA) that an assessment is needed to address the remaining barriers to RNG use in transportation. We agree with the comments that addressing barriers to producing and using RNG fuels in the

transportation sector is an important research area, particularly for HDV. However, in regards to the suggestion that an assessment is needed, we note that APEP is directly addressing this research need via a three year project funded by the California Air Resources Board studying the best use of renewable fuels in the HDV sector. The project, entitled "The Optimal Route for a Clean Heavy Duty Sector in California", will assess the potential implementation of renewable pathways including biomass and biogas (including RNG), power-to-gas, and vehicle-to-grid strategies to support fuel production and distribution for HDV to determine preferred uses and strategies in meeting California's long-term energy and environmental goals. The analysis will characterize and quantify associated economics and emissions of GHG and criteria pollutants of different fuel pathways across an encompassing set of scenarios considering a range of advanced vehicle technologies in 2050. Additionally, a component of the project is to "Provide guidance on overcoming barriers to implementing zero and near-zero emission heavy duty pathways". Therefore, APEP will specifically seek to identify the best production methods of RNG for HDV use, as well as to identify and suggest potential methods to overcome current barriers, which directly addresses the issue raised by the CBA.

However, APEP would like to encourage the CEC to pursue additional research associated with the use of RNG in the transportation sector to ensure the maximum attainment of environmental co-benefits from RNG production and utilization in California. For example, the use of RNG may be most feasible for reducing GHG within other transportation sub-sectors including off-road sources, ships, rail, and aircraft.

Improving the environmental performance of fuel production and use within those areas can attain important environmental quality benefits, including improvements to regional air quality. For example, Figure 1 below demonstrates the notable impact on ozone and PM2.5 air pollution from off-road sources in 2035, highlighting the need for deployment of zero- and near-zero emission technology development and deployment. The use of RNG to supply fuel for off-road sources can ensure the co-benefit of GHG reduction.
Additional areas of research APEP believes should be supported by CEC investment include:

- Barriers to, and best practices, for RNG production and use in other transportation sectors including off-road, rail, ships, and aircraft
- Air quality impacts of increased ammonia emissions arising from post-combustion clean-up systems utilized by NG and RNG HDV
- The environmental impacts (air quality, GHG, water) of biomass distribution for energy recovery
- Consideration of resource availability and impacts from utilization of RNG feedstocks at the national level

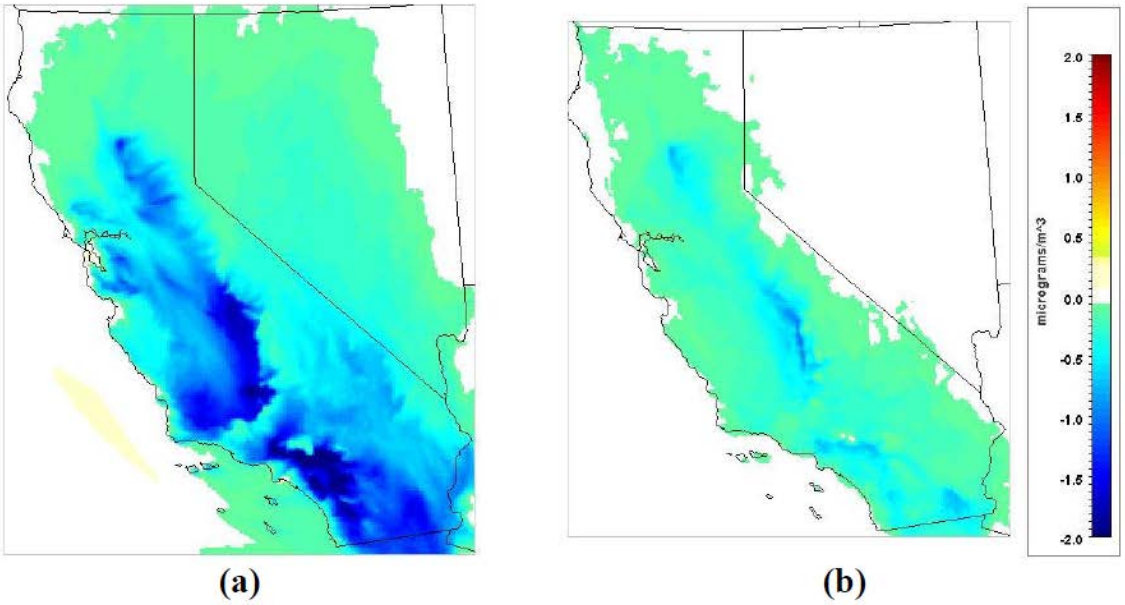

Figure 1. Predicted impacts on a) max 8-h avg. ozone and b) 24-hr avg. $PM_{2.5}$ from off-road sources in 2035.

Energy Commission Response:
Energy Commission staff are aware of UCI's "The Optimal Route for a Clean Heavy Duty Sector in California" project and will consider its findings when pursuing research in natural gas-related transportation. Staff will consider conducting future assessments that can address the additional areas of research identified in APEP's comment.

The Energy Commission is also aware of the high potential GHG and air quality benefits of increased RNG use in large off-road applications such as rail and marine. The Energy Commission has recently published a report developed by Gladstein, Neandross, & Associates titled "The Feasibility, Issues, and Benefits Associated with Expanded Use of Natural Gas at Seaports and Other High Horsepower Applications".[1] The report focuses on marine vessels and locomotives as key high horsepower port applications that consume high volumes of fuel, have high associated environmental impacts, and offer the potential to achieve significant environmental benefits by using RNG. The proposed Natural Gas R&D program expansion could allow the Energy Commission to fund larger research projects that may be needed to address the remaining barriers to increasing RNG utilization in large off-road applications.

[1] Leonard, J. and Couch, P. The Feasibility, Issues, and Benefits Associated With Expanded Use of Natural Gas at Seaports and Other High Horsepower Applications. http://www.energy.ca.gov/2017publications/CEC-500-2017-032/CEC-500-2017-032.pdf