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Comments of Energy & Environment, Inc. (E&E) on ARFVTP

Additional submitted attachment is included below.

In the Matter of: 2017-2018 Investment Plan Update	Docket No. 16-ALT-02 RE: Alternative and Renewable Fuel and Vehicle Technology Program

December 29, 2016

Commissioner Janea Scott
California Energy Commission
Sacramento, CA

Dear Commissioner Scott and California Energy Commission Staff,

Energy & Environment, Inc. (E&E) is pleased to provide these comments to the California Energy Commission (CEC) in response to the 2017- 2018 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP).

I. Introduction to E&E and Net Zero LNG™

For two decades, E&E has provided services to the oil and gas production and processing, chemical, and petrochemical industry and has leading expertise in the field of landfill gas generation, abatement and renewable energy production. Our presence and experience in the marketplace has given us in-depth knowledge of energy production technologies and markets, especially in the clean energy sectors. E&E has been credentialed with the design, manufacture, and installation of combined heat and power (CHP) and pollution abatement systems for industrial manufacturers and gas processing sites.

Most recently, E&E has invested in the development of "Net Zero LNG™" a liquified natural gas (LNG) production process that results in Net Zero emissions of greenhouse gases. Net Zero LNG is a novel technology that converts low-quality associated petroleum gas (APG), which would otherwise be flared or re-injected, into LNG. E&E's pilot Net Zero LNG plant is capable of producing up to 11,000 gallons per day of LNG from 1.5 million cubic feet of APG. E&E has entered this market based on decades of experience, research, and extensive engagement in the gas processing design and service industry.

E&E is hopeful that the ARFVTP can be a catalyst for the productive reuse of APG into LNG and introduction of Net Zero LNG™ to a broader market. Accordingly, we request the ARFVTP 2016-2017 Investment Plan provide the flexibility for Net Zero LNG to qualify for funding under the "Emerging Opportunities" category.

II. Technical Summary

Net Zero LNG™ is produced by an innovative five-step process that eliminates byproduct waste and combustion-related emissions. Steps include the following: 1) gas filtration, 2) gas purification, 3) clean power production, 4) LNG production, and 5) storage and distribution.

1) **Gas filtration.** Low-quality APG is cleaned and filtered by desecants and mechanical processes, which removes particulates and moisture. An iron sponge then removes sulfur, resulting in clean, unpurified gas for further processing.
2) **Gas purification.** Methane is separated from the clean, unpurified gas through pressure swing absorption (PSA) and temperature swing absorption (TSA), resulting in 97% biomethane, which is required for LNG production.
3) **Clean power production.** Resulting waste methane is used for power generation for the facility. A CHP fuel cell generator is used to virtually eliminate stationary source criteria air pollutants, maintain high electrical efficiency, and provide thermal energy needed in the closed loop system.
4) **LNG production.** Purified gas is liquefied by a cryogenic refrigeration and liquefaction process, which occurs at approximately -256 degrees Fahrenheit.
5) **LNG storage.** Resulting LNG is stored in a specialized tank for truck loading and shipment. Typical LNG truck carriers are 8,000 to 12,000 gallons for larger logistical distributions.

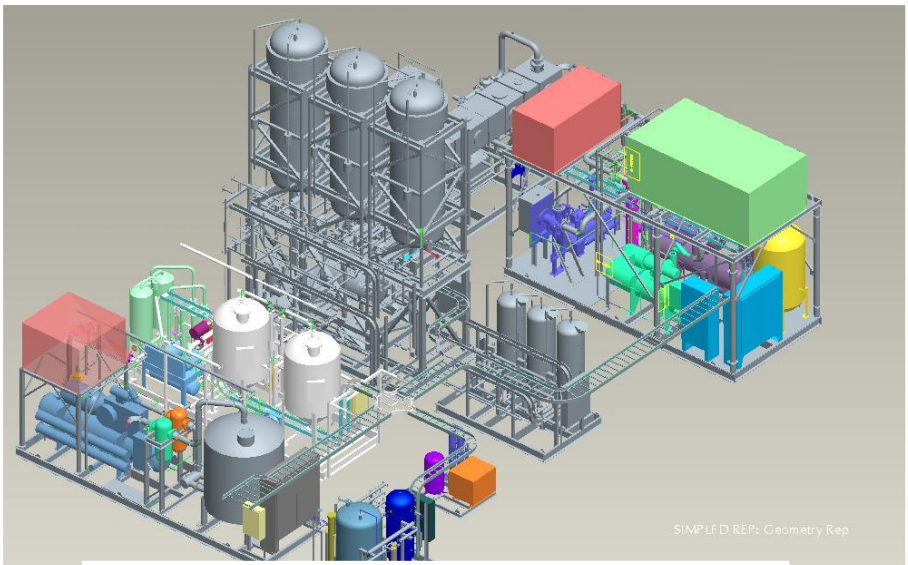


Figure 1: Net Zero LNG Facility Schematic

Net Zero LNG technology is based on a pilot facility acquired by E&E in 2011, which had been originally developed by Prometheus Energy Company for use at a landfill in Orange County, CA. E&E has made several technical enhancements and optimized the system for use of APG as feedstock, while reducing emissions previously resulting from combustion by substituting a fuel cell generator.

Figure 2: Net Zero LNG Pilot™ Facility, Acquired in 2011 by E&E

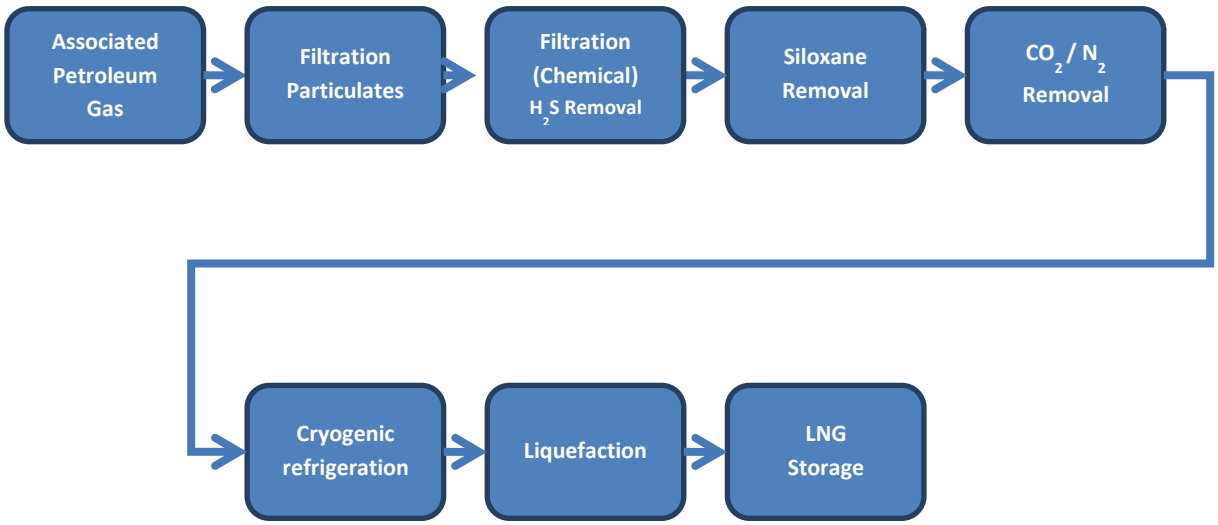


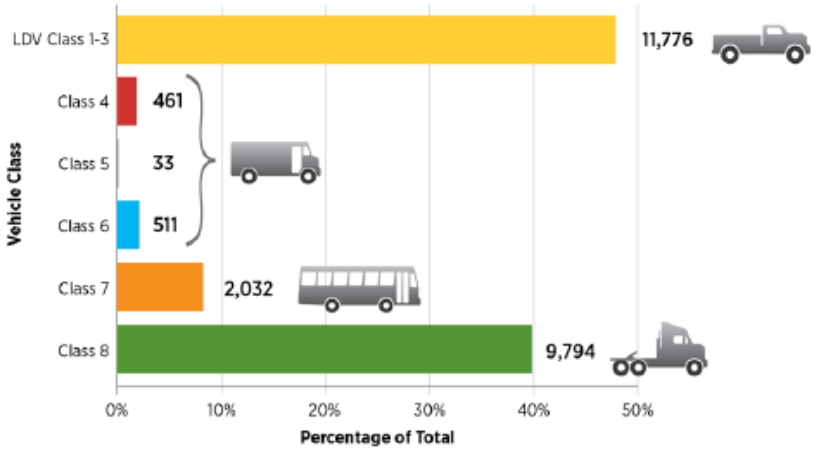
Figure 3: Net Zero LNG™ Process Diagram

III. Adoption of LNG Heavy Duty Vehicles to Address Mobile Source Pollution

The CEC's "Natural Gas Vehicle Research Road Map," released in July 2015, establishes natural gas as a viable and cost-effective alternative to diesel fuel and gasoline, with the potential to significantly reduce California's mobile source carbon emissions and air pollutants.[1]

According to the CEC study, by the end of 2013, roughly 24,600 natural gas vehicles were registered in California; about half of those fall into medium (Class 4-6) and heavy-duty vehicle classes (Class 7-8), and the remaining are light-duty vehicles (LDV Class 1-3) (Figure 9). Light-duty vehicles, and Class 8 trucks make up the largest portion of California's natural gas vehicle fleet by a substantial margin.[2] Liquefied natural gas (LNG) is more likely a replacement for diesel operations and typically used for larger vehicles such as Class 8 trucks where driving range and energy density are particularly critical. LNG is also of interest as a viable fuel for rail, marine, and other high horsepower operations.[3]

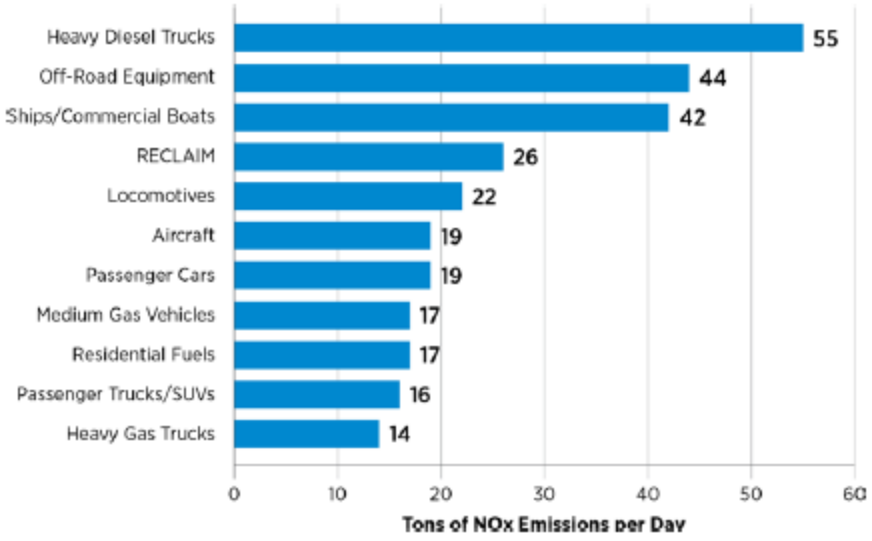
Figure 9: Market Share of Natural Gas Vehicles in California (2013)



Continued adoption of LNG vehicles, particularly in heavy-duty vehicle classes, can significantly address mobile source criteria air pollution. Mobile sources are the largest contributor of NOx in California, with a majority of these emissions attributed to heavy-duty vehicles, so a significant portion of the necessary reductions must come from heavy-duty vehicles.[4]

[1] Schroeder, Alex. (National Renewable Energy Laboratory). 2015. *2015 Natural Gas Vehicle Research Roadmap.* California Energy Commission. Publication number: CEC-500-2015-091-D.
[2] *Id.*, p. 15.
[3] *Id.*, p. 8-9.
[4] *Id.*, p. 19.

Figure 12: Projected Sources of NO_x Emissions in South Coast Air Basin by 2023 (tons/day)



LNG occupies only a fraction (1/600) of the volume of natural gas, and takes up less space, it is more economical to transport across large distances and can be stored in larger quantities.[5] LNG is a price-competitive source of energy that is ideally suited to California's heavy-duty transportation needs.

IV. Environmental Benefit of Productive Reuse of APG

APG is a form of natural gas which is found with deposits of petroleum, which historically has been released as a waste product from the petroleum extraction industry.[6] California regulations discourage flaring of APG in favor of productive reuse. Net Zero LNG contemplates the productive reuse of APG for two purposes: 1) LNG production, and 2) clean power production through fuel cells.

Typically, conversion of APG to LNG requires significant upfront capital investment. The Net Zero LNG system is designed to be portable and modular, and proximately located near customer demand to dramatically reduce LNG transportation costs and emissions.

Due to high infrastructure costs and environmental considerations, there are no existing LNG import or export terminals in the state. Net Zero LNG™ provides an opportunity to leverage an existing in-state waste feedstock, APG, to produce a cost effective alternative to large-scale LNG facilities.

The use of combined heat and power (CHP) fuel cell technology for power generation in the Net Zero LNG process further enhances environmental benefits. Itron, Inc.'s most recent Impact Evaluation of

[5] http://www.energy.ca.gov/lng/faq.html#1300
[6] "Glossary of terms used in Petroleum Reserves/Resources Definitions". The Society of Petroleum Engineers. 2005.

distributed generation technologies concluded that while CHP fuel cells decreased greenhouse gas (GHG) emissions compared to the California grid, internal combustion engines and micro-turbines increased GHG emissions.[7]

As Itron explained, "CHP fuel cells have a higher emissions rate than the electrical power plants that they avoid but are able to overcome this deficit by recovering useful heat for heating and cooling services. The result is a negative emissions impact relative to the conventional energy services baseline." Itron continues, "Internal combustion engines … had high emissions rates and did not recover sufficient useful heat to achieve negative GHG impacts."[8]

V. Conclusion

Earlier this year, a Columbia University report on productive reuse of APG summarized that while "APG utilization is economically viable and socially necessary as a solution to harmful flaring operations, oil companies are unlikely to commit financial resources to utilization projects in the absence of regulatory institutions that adequately incentivize the conversion of the necessary facilities, foster an investor-enabling environment for the construction of new infrastructure, and facilitate operators in overcoming a varied set of financial and technical constraints."[9]

In California, the ARFVTP program can be a key catalyst to reduce barriers for APG utilization as an otherwise wasted fuel resource. Net Zero LNG™ provides an innovative solution to put APG to its best and highest use consistent with state policy goals to de-carbonize mobile and stationary pollution sources. E&E greatly appreciates the opportunity to make these comments and the thoughtful consideration of the CEC in the months ahead.

Respectfully submitted,

Amir Sardari
President & CEO
Energy & Environment, Inc.

Email: amir@cleanenergysolutions.net
Tel: 714-545-7805
Cell: 949-637-1528

[7] 2013 SGIP Impact Evaluation, Chapter 7-6, available at www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=7909.
[8] *Id.*
[9] Shay Banerjee, Perrine Toledano, "A Policy Framework to Approach the Use Of Associated Petroleum Gas," Columbia Center on Sustainable Investment, Columbia University, (2016).