Attachment 1: Description of Emissions Reduction Measure Form

Title: ***Renewable Fuel (i.e. Biomethane) in the Natural Gas Sector***

Type of Measure (check all that apply):

☑ Direct regulation
☑ Monetary Incentive
☐ Voluntary
☐ Other Describe:
☐ Market-based compliance:
☑ Non-monetary incentive
☑ Alternative Compliance Mechanism

Responsible Agency: California Public Utilities Commission, California Energy Commission

Sector:

☐ Transportation
☐ Other Industrial
☑ Agriculture
☐ Sequestration
☐ Electricity Generation
☐ Refineries
☐ Cement
☑ Other Describe: Natural gas

2020 Baseline Emissions Assumed (MMT CO2E): 92 MMTCO2e

82.2 MMTCO2e from end-use consumption of natural gas,[1] and 9.4 MMTCO2e from methane emissions from dairy cows.[2]

Percent Reduction in 2020: 8% (7.2 MMTCO2e)

Cost-Effectiveness ($/metric ton CO2E) in 2020: $4 to $17 per metric ton CO_2e

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Description:

The natural gas sector is a significant source of greenhouse gas (GHG) emissions in California, contributing about 14% of statewide emissions (excluding natural gas used to generate electricity).[3] The natural gas sector is the third largest source of emissions, behind the

[1] The California Energy Commission's forecast for statewide consumption of natural gas in 2016 is 14,625 MM Therms, with a growth rate from 2008-2016 of 1.44% per year. Extrapolating to 2020 results in statewide consumption of 15,486 MM Therms in 2020. Using the conversion of 53.06 kg CO2e per MMBtu, from the Climate Action Team's updated macroeconomic anlaysis, results in 82.17 MMTCO2e. (California Energy Commission, *California Energy Demand 2008-2018*, Staff Draft Report, CEC-200-2007-015SD, July 2007, p. 1-9; Climate Action Team Economics Subgroup, *Updated Macroeconomic Analysis of Climate Strategies Presented in the March 2006 Climate Action Team Report*, Public Review Draft, September 7, 2007.)

[2] The CARB draft inventory reports CH_4 emissions from dairy cows of 5.9 MMTCO2e in 2004 (3A2ai, "Livestock population - Dairy Cows > CH4"). The average growth rate from 1990 to 2004 was 2.9%. Assuming the same average growth rate through 2020 results in a baseline estimate of 9.4 MMTCO2e. This is similar to the estimate of baseline emissions in ICF Consulting, *Emission Reduction Opportunities for Non-CO2 Greenhouse Gases in California*, for California Energy Commission, CEC-500-2005-121, July 2005, p. 40.

[3] California Public Utilities Commission, *Attachment A to Administrative Law Judge's Ruling Regarding Comments on Staff Natural Gas Proposal and Notice of Prehearing Conference*, R.06-04-009, July 12, 2007, p. 6.

transportation and electricity sectors. However, policies to encourage reductions in the GHG emissions from the natural gas sector have lagged behind those in other sectors. While the California Public Utilities Commission (CPUC) and California Energy Commission's (CEC) joint *Energy Action Plan* contains a few actions to "ensure reliable, long-term natural gas supplies to California at reasonable rates," the policy framework is not as robust as that for the electric sector.[4]

Renewable fuels (i.e., biomethane)[5] are one of the key strategies to reduce GHG emissions from the natural gas sector, while stabilizing rates and improving the security of the natural gas supply. Biomethane is natural gas produced by "upgrading" biogas to improve the heating value and to remove impurities.[6] Biogas is a naturally occurring byproduct of the anaerobic digestion of organic waste materials such as manure.

The Governor's *Bioenergy Action Plan for California* states a policy objective to "Maximize the contributions of bioenergy toward achieving the state's petroleum reduction, climate change, renewable energy, and environmental goals."[7] To date, the state has only encouraged the use of biomethane to generate renewable electricity, primarily onsite, to contribute to meeting the state's RPS.[8] PG&E recently signed contracts for two projects to inject biomethane from dairies into the natural gas pipelines to contribute to its RPS targets.[9] However, biomethane remains a largely untapped resource that can contribute to meeting the Bioenergy Action Plan's objectives and provide significant greenhouse gas reductions.[10]

The CPUC and CEC should adopt a "loading order" of resources for the natural gas sector to prioritize: first, all cost-effective natural gas efficiency and solar resources, and second, renewable fuels like biomethane. While natural gas efficiency has already been codified as the state's top priority resource for the sector,[11] this "loading order" will provide the utilities with needed policy guidance to seek out low-carbon fuels before conventional sources of natural gas.

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[4] California Public Utilities Commission and California Energy Commission, *Energy Action Plan II*, September 21, 2005.

[5] We assume that the use of solar energy to reduce natural gas demand is considered part of the "energy efficiency" category for the natural gas sector, since the CPUC has allowed solar hot water measures to qualify as energy efficiency measures. Solar energy, promoted through programs like that envisioned by AB 1470, is a key strategy to reduce GHG emissions in the natural gas sector.

[6] The carbon dioxide, water, hydrogen sulfide and other impurities in biogas are removed to produce biomethane. Krich et al, *Biomethane from Dairy Waste: A Sourcebook for the Productions and Use of Renewable Natural Gas in California*, for Western United Dairymen, July 2005, p. xv.

[7] Governor Arnold Schwarzenegger, *Bioenergy Action Plan for California*, CEC-600-2006-010, July 2006.

[8] The CEC's recent update to its Renewables Portfolio Standard (RPS) Eligibility Guidebook determined that electricity generated from biomethane injected into a natural gas pipeline is an RPS eligible renewable energy resource. CEC, *Renewables Portfolio Standard Eligibility*, Second Edition, CEC-300-2007-006-CMF, March 2007, pp. 22-23.

[9] See CPUC Resolutions E-4076 (May 24, 2007) and E-4083 (August 23, 2007) approving PG&E's contracts for biomethane to contribute to its RPS targets.

[10] In a recent joint application to the CPUC, SDG&E and Southern California Gas state that they "believe that biomethane is an under-developed renewable resource and that more should be done to develop bioenergy resources in the State." San Diego Gas & Electric and Southern California Gas Companies, Application 07-08-031, *Climate Action Initiative*, August 31, 2007, p. III-9.

[11] Senate Bill 1037 (Kehoe, 2005)

In addition, the CPUC, in collaboration with the CEC, should explore other policies to require or encourage the natural gas utilities to increase procurement of biomethane, such as:

- *Renewable Fuel Portfolio Standard*. A Renewable Fuel Portfolio Standard could function like the RPS in the electric sector, requiring the utilities to increase procurement of biomethane every year to reach a certain percent of supply by 2020.
- *Enable and Encourage Long-Term Contracts*. While long-term contracts for supply are commonplace in the electric sector, they are much less common in the natural gas sector. Just as electric renewable resources need the certainty of long-term contracts to get financed, biomethane facilities need long-term contracts to be viable.[12] Long-term fixed-price contracts can provide significant benefits to customers by stabilizing rates.
- *Facilitating Interconnection.* Access to the utilities' natural gas pipelines will be essential to enable biomethane to become a part of the state's natural gas supply. A recent University of San Diego report recommends that the "CPUC should assess existing interconnection processes and costs to determine whether they are appropriate for introduction of biomethane into the natural gas transmission system" and to "consider subsidizing and standardizing interconnection costs among gas utilities in California."[13] In their recent application for a Climate Action Initiative to the CPUC, SDG&E and Southern California Gas companies also propose to create an "interconnection allowance" so that "if a biomethane supplier delivers over 500 Mcf/d, interconnection costs would be rolled into rates and paid for by all customers."[14]
- *Technology Transfer.* Several countries in Europe have significant experience with biomethane, and California should learn from their success.[15] This effort should build on the 2006 Memorandum of Understanding between California and Sweden to cooperate on developing a biomethane industry.[16]
- *RD&D.* The CEC should expand the Public Interest Energy Research program's focus on RD&D to advance biomethane. The PIER program's *Natural Gas Research Investment Plan* includes development of renewable energy technologies to replace the use of natural gas as a strategic objective, but the emphasis on this effort could be expanded and supplemented with a detailed plan to advance biomethane.[17]

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[12] A recent report found that "If biomethane facilities are going to become viable…they will likely need…a long-term fixed price contract…" Krich et al, *Biomethane from Dairy Waste: A Sourcebook for the Productions and Use of Renewable Natural Gas in California,* for Western United Dairymen, July 2005, p. 17.

[13] Anders, S., *Biogas Production and Use on California's Dairy Farms,* University of San Diego Law School, August 2007, p. ix.

[14] San Diego Gas & Electric and Southern California Gas Companies, Application 07-08-031, *Climate Action Initiative,* August 31, 2007, p. III-20.

[15] Anders, S., *Biogas Production and Use on California's Dairy Farms,* University of San Diego Law School, August 2007, p. v.

[16] State of California Resources Agency, "Officials from California and Sweden Agree to Work Together on Biomethane and Renewable Fuels," June 29, 2006. SDG&E and Southern California Gas state that they are collaborating with Swedish companies to explore technology transfer. San Diego Gas & Electric and Southern California Gas Companies, Application 07-08-031, *Climate Action Initiative,* August 31, 2007, p. I-7.

[17] CEC, *Public Interest Energy Research Program: 2007-2011 Natural Gas Research Investment Plan,* CEC-500-2006-017-CMF, August 2006, p. 17.

Emission Reduction Calculations and Assumptions:

Biomethane can reduce global warming pollution both by providing a renewable source of natural gas and thereby eliminating the net CO_2 emissions that would otherwise be emitted from burning natural gas, and by preventing the release of methane, which is a potent greenhouse gas.

Assuming that 14.6 billion cubic feet of biomethane per year could be captured from dairies in California,[18] with a heat content of 1,000 Btu per standard cubic foot,[19] and that 1 cubic foot of natural gas weighs 19.26 grams:[20]

The emission reductions from replacing natural gas with a renewable fuel and eliminating the net CO_2 emissions that would otherwise be emitted are 0.8 MMTCO2e.[21] The emission reductions from avoided methane emissions are 6.5 MMTCO2e.[22] <u>In total, the emission reductions are 7.2 MMTCO2e.</u>

This estimate is conservative as it relies on a 2005 estimate of biomethane production from dairies, and does not include biomethane from other potential sources such as wastewater treatment facilities. For example, a University of San Diego report estimates that the technical potential for biomethane from wastewater treatment is about 11 billion cubic feet per year (or about 75% of the potential for biomethane from dairies).[23]

This estimate is also generally consistent with other recent estimates of the potential for emission reductions from manure management.[24]

Cost-Effectiveness Calculation and Assumptions:

Assuming that it costs $8.44 to $15.24 per thousand cubic feet to produce biomethane,[25] the total cost of producing 14.6 billion cubic feet of biomethane would range from $123 to $223 million.

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[18] Krich et al, *Biomethane from Dairy Waste: A Sourcebook for the Productions and Use of Renewable Natural Gas in California,* for Western United Dairymen, July 2005, p. 3.
[19] Ibid, p. 5.
[20] U.S. Environmental Protection Agency, *Unit Conversions, Emissions Factors and Other Reference Data,* November 2004, p. 4, www.epa.gov/appdstar/pdf/brochure.pdf.
[21] (14.6 billion ft^3 of methane per year) * (1,000 Btu/standard cubic foot)* (1 MMBtu / 10^6 Btu) *(53.06 kg/MMBtu) * (1 metric ton / kg) = 0.8 MMTCO2e.
[22] (14.6 billion ft^3 of methane per year) * (19.26 g / 1 ft^3) * (1 ton / 10^6 g) * (23 metric ton CO2e / ton methane) = 5.9 MMTCO2e. The global warming potential for methane is from the *Climate Action Team Report to Governor Schwarzenegger and the Legislature*, March 2006, p. 15.
[23] Anders, S., *Biogas Production and Use on California's Dairy Farms,* University of San Diego Law School, August 2007, p.7.
[24] A recent CEC report finds up to 6.24 MMTCO2e could be reduced from manure management. (ICF Consulting, *Emission Reduction Opportunities for Non-CO2 Greenhouse Gases in California*, for California Energy Commission, CEC-500-2005-121, July 2005, p. 40.) The Center for Clean Air Policy estimates that 65% of emissions from manure management could be captured. This would yield 6.1 MMTCO2e of reductions when applied to our emissions estimate of 9.4 MMTCO2e from manure management in 2020. (Center for Clean Air Policy, *Prospects for Participation of Methane Sectors in Emissions Treading Programs in California*, October 14, 2005, p. 2.)
[25] Krich et al estimate the cost of a digester and a biomethane plant to range from $8.44 to $11.54 per thousand cubic feet, not including storage or transport, and that storage and transport could add another $3.70 per thousand

Further assuming that biomethane avoids the use of natural gas that costs on average $6.70 per MMBtu,[26] the benefits of using 14.6 billion cubic feet of biomethane would be $97.8 million.[27]

This results in net costs (i.e., costs minus benefits) ranging from $25 to $125 million. Dividing by emission reductions of 7.2 MMTCO2e yields a cost-effectiveness range of approximately $4 per metric ton CO_2 to $17 per metric ton CO_2e.

This estimate is generally in the same range as other recent estimates, including Southern California Gas and San Diego Gas & Electric's estimate that emission reductions from biomethane will cost in the range of $0 to $40 per ton,[28] and ICF Consulting's estimate that emission reductions from biomethane would cost up to $55 per metric ton CO_2e.

Implementation Barriers and Ways to Overcome Them:

While biogas from dairies can be a source of either renewable electricity or renewable natural gas, the state's efforts have been primarily focused on the former to date. However, burning biogas to produce electricity creates problems with criteria pollutants, discussed further below. Using biomethane as a renewable source of natural gas can avoid this problem with local pollutants.

Dairies may be required to use some of the technologies that are used to produce biomethane as pollution control measures pursuant to the Clean Air Act. Clearly, any new policies (particularly any incentives) should encourage measures beyond what is required by law or regulation. In addition, the CPUC and CEC should ensure that policies adopted to encourage use of biomethane in the natural gas sector are sufficient to enable the use of biomethane, but not excessive. In particular, the policies should not encourage the creation of further large scale dairies, which could create other types of environmental problems.

Potential Impacts on Criteria and Toxic Pollutants:

Injecting biomethane into the utilities' natural gas pipelines to replace conventional supplies of natural gas is expected to reduce criteria pollutants at the source of the biomethane (e.g. dairy). Digesters to produce biogas can significantly reduce emissions of smog-forming pollutants. However, combusting biogas produces NO_x, and burning biogas to generate electricity emits more NO_x than flaring the biogas.[29] Catalytic converters to reduce NO_x emissions can be costly because the impurities in biogas will shorten the life of catalytic converters, thereby raising the

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cubic feet. (Krich et al, *Biomethane from Dairy Waste: A Sourcebook for the Productions and Use of Renewable Natural Gas in California*, for Western United Dairymen, July 2005, pp. 14, 16.)

[26] $6.70 per MMBtu represents the average price of natural gas forecasted in recent report: Climate Action Team Economics Subgroup, *Updated Macroeconomic Analysis of Climate Strategies Presented in the March 2006 Climate Action Team Report*, Public Review Draft, September 7, 2007, p. 14.

[27] 14.6 billion cubic feet * (1000 Btu / cubic foot) * (MMBtu/10^6 Btu) * ($6.70 / MMBtu) = $97.8 million.

[28] San Diego Gas & Electric and Southern California Gas Companies, Application 07-08-031, *Climate Action Initiative*, August 31, 2007, p. II-5.

[29] Krich et al, *Biomethane from Dairy Waste: A Sourcebook for the Productions and Use of Renewable Natural Gas in California*, for Western United Dairymen, July 2005, pp. 34,38.

cost of reducing the emissions.[30] The solution is to upgrade biogas to biomethane, removing the impurities. However, once the biogas has been upgraded to biomethane, it may be more advantageous to use it as renewable natural gas injected into the gas pipeline, and it may produce greater GHG reductions by combusting the biomethane at a more efficient central station electricity generator.[31]

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[30] Ibid, p. 37.
[31] Ibid, p. 109.