Attachment 1: Description of Emission Reduction Measure Form

Please fill out one form for each emission reduction measure. See instructions in Attachment 2.

Title: Amyris Biomass Derived Diesel, Jet, and Gasoline

Type of Measure (check all that apply):

☐ Direct Regulation	☐ Market-Based Compliance
☐ Monetary Incentive	☐ Non-Monetary Incentive
☐ Voluntary	☒ Alternative Compliance Mechanism
☐ Other Describe:	

Responsible Agency:

Sector:

☒ Transportation	☐ Electricity Generation
☐ Other Industrial	☐ Refineries
☐ Agriculture	☐ Cement
☐ Sequestration	☐ Other Describe:

2020 Baseline Emissions Assumed (MMT CO2E): 372 MMT

Percent Reduction in 2020: 80-95% reduction per substituted gallon

Cost-Effectiveness ($/metric ton CO2E) in 2020: n/a

Description:

Amyris (www.amyris.com) is an Emeryville, CA based company developing a range of products that aim to help address important global problems such as malaria and global warming. We plan to start marketing our biomass-derived hydrocarbon fuels as early as 2010.

Amyris uses rapid enzymatic pathway construction techniques to engineer microorganisms capable of producing high-value compounds. We are currently developing a large-scale fermentation process that will use these microbes to produce second-generation biofuels that we expect will be cost-effective, environmentally-friendly, and compatible with both existing engines and the current fuel distribution infrastructure. We intend to partner with existing ethanol producers that use low-cost, low-carbon feedstocks (e.g., sugarcane, cellulose) for production.

Amyris is developing a product portfolio that we expect will include a bio-diesel, a bio-jet fuel, and a bio-gasoline. Amyris expects that its bio-diesel will achieve lower costs and much greater scale than vegetable oil based bio-diesels. Testing conducted to date indicates that our bio-diesel product is inherently stable in cold temperatures. Furthermore, we expect that it will not break down during storage and transport like conventional bio-diesel. Finally, it can be mixed with CARB ULSD at percentages up to 65% to create a blended product that meets the ASTM D-975 specification. Amyris' bio-jet fuel, which meets the ASTM D-1655 specification (except the requirement that the product be petroleum-derived) without blending, has a freezing point of -70℃ which is significantly lower than the Jet A specification of -47℃. We expect that Amyris' bio-gasoline will have an energy density comparable to standard gasoline (i.e., much higher than ethanol) and a low vapor pressure that could enable low-cost and/or low VOC blended products.

Emission Reduction Calculations and Assumptions:

Note: all results are presented on a per gallon (BTU adjusted) basis as our 2020 projections for volumes of bio-gasoline, bio-diesel, and bio-jet are confidential.

2020 Baseline Emissions:
- Based on CARB projections for fuel consumption in 2023 and growth rates between 2003 and 2023, it is estimated that California will consume 3.8 B gallons of diesel fuel, 19 B gallons of gasoline, and 6.6 B gallons of jet fuel in 2020. (Source: http://www.energy.ca.gov/reports/2003-10-01_100-03-016.PDF)
- Based on per gallon estimates of life cycle emissions, we estimate that this volume of fuels will result in 384 MMT CO2E of greenhouse gas emissions if conventional fuels are used to meet demand. (Sources: Farrell et. al. "A Low-Carbon Fuel Standard for California, Part 1: Technical Analysis", May 2007; estimate that jet fuel emissions are 30% greater than diesel fuel emissions on a per gallon basis)

Percent Reduction in 2020:
- Amyris intends to produce its biofuels with low-carbon, low-cost feedstocks such as sugarcane and cellulose. Among other locations, we are investigating the Imperial Valley of California as a potential location for sugarcane-based production.
- Amyris biofuels will be produced in modified ethanol plants. As a result, we have chosen to make our initial estimates of greenhouse gas reductions by modifying existing estimates of life cycle greenhouse gas reductions for ethanol. Rather than speculating about life cycle emissions from low-carbon intensity feedstock/geography combinations that are not mature (e.g., US cellulosic ethanol, US sugarcane ethanol), we have chosen to initially model our greenhouse gas emissions on production from Brazilian sugarcane.
- A preliminary life cycle analysis for Amyris' bio-diesel fuel produced in Brazil and transported to California for use indicates a 92% reduction in life cycle emissions versus CARB ULSD. For context, this analysis assumes that Brazilian ethanol transported to the US would drive a 86% reduction in life cycle emissions versus the marginal gallon of

CA gasoline. (Sources: Farrell et. al., op. cit.; Macedo et. al., "Assessment of greenhouse gas emissions in the production and use of fuel ethanol in Brazil", April 2004; Argonne National Laboratory GREET model; Amyris analysis).
- Details of our analysis are not presented here as a portion of the reduction results from process-specific changes that are confidential.
- As this estimate was derived from what must be referred to as a "preliminary" analysis (focused on a single product, produced from one geography/feedstock combination, substituting for one existing product/geography combination), we believe that it is appropriate at this time to use a range of 80-95% as an estimate of the greenhouse gas reduction potential across our fuels spectrum.
- We intend to refine this life cycle analysis over time.

Cost-Effectiveness Calculation and Assumptions:

Our target is to have our biofuel products be competitive with conventional petroleum based fuels, without subsidies, at crude prices greater than $45/bbl. Therefore, if we achieve our cost targets and if crude prices are greater than $45/bbl, there should be no differential cost to using our fuels.

Implementation Barriers and Ways to Overcome Them:

Potential barriers include incentive policies that favor specific technologies and/or do not favor low carbon fuels, no/limited government funding for RD&D, and trade restrictions.

State and federal government policies that will be important to support our efforts include:
1) Expansion of the federal renewable diesel credit to include all renewable diesels, including renewable diesel produced via means other than "thermal depolymerization" and including bio-jet fuels
2) A revenue neutral re-allocation of fuel taxes such that taxes are proportional to life cycle greenhouse gas emissions (i.e., low carbon footprint fuels require low/no tax while conventional petroleum based fuels require higher taxes)
3) Funding for R&D and pilot plants for second-generation biofuels from existing low-carbon feedstocks such as sugarcane or cellulose
4) No change to existing biofuels importation duties (e.g., no new duties on non-ethanol biofuels imported into the United States)

Potential Impact on Criteria and Toxic Pollutants:

Unlike conventional biofuels such as ethanol and FAME biodiesel, our biofuels are pure hydrocarbons that do not contain oxygen. The biofuel components themselves are not expected to be toxic. In addition the the significant potential reduction in greenhouse gas emissions that we describe above, fuels experts that we have engaged as consultants expect that our biofuels should have criteria pollutant profiles that are equal or better than conventional petroleum based fuels. We intend to conduct

engine/emissions testing in early 2008 that should provide us with data on the pollutant profile for our bio-diesel fuel. We certainly intend to conduct similar testing for our bio-gasoline and bio-jet fuel products as part of obtaining regulatory approval for these products.

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