LOTUS
ENGINEERING

June 23, 2010

California Air Resources Board
1001 "I" Street
P.O. Box 2815
Sacramento, CA 95812

Subject: Comments on CARB AB118 Air Quality Improvement Program FY10-11 Funding Plan

The California Air Resources Board's AB118 Air Quality Improvement Program Investment Plan for FY10-11 (AQIP) provides a critical opportunity to accelerate the development and commercialization of alternative non-petroleum fuels. Unfortunately, the current AQIP excludes the crucial fuel pathway of Renewable Methanol (RM) which needs to be included in some fashion.

Fundamentally, RM is defined as methanol which does not derive from fossil hydrocarbon resources. From a practical matter, it is also defined as fuel which derives from CO_2 feed stocks rather than conventional CO-based feed stocks which are the source of conventional Natural Gas (NG)-to-methanol synthesis plants. From a policy perspective, renewable methanol offers well-to-wheel (WTW) greenhouse gas (GHG) reduction benefits far greater than conventional methanol. Given the scale of petroleum fuel use at present, all possible low and zero carbon pathways should be reflected in the AQIP. It is therefore noteworthy that the latest version of the AQIP does not include RM.

There are many reasons to consider amending the AQIP to include a specific reference to RM. One of the key opportunities provided by RM is that it is derived from CO_2 sources which are not associated with fossil fuels. The CO_2 feed stocks for RM can be derived from diverse biological and non-biological sources, including recycled glycerine from biodiesel production, CO_2 from industrial facilities and renewable geothermal CO_2 sources. Due to its feedstock diversity, RM fuel could also provide a means of avoiding a possible "biofuel limit," which could prove important to minimize possible competition between certain types of biofuel production and food or agricultural production. For example, unlike traditional ethanol from corn or possibly other food-derived or bio-derived ethanol pathways, there is little serious prospect for indirect land use effects from RM pathways.

There are several important recent initiatives regarding RM which should be considered as a foundation for amending the Board's AQIP to incorporate RM. Dr. George Olah,

1254 N. Main Street, Ann Arbor, MI 48104 Phone: 734-995-2544 Fax: 734-995-9301

Nobel Laureate, has done pioneering work on the use of CO_2 as a feedstock for methanol production.[1] Based on the work of Dr. Olah and others, Lotus has published SAE papers outlining the rationale for Renewable Methanol from CO_2 feed stocks and has demonstrated its use in optimized vehicles.[2] Mitsui Chemicals has built a pilot scale facility in Japan which is producing 10 tons per year of CO_2 based methanol. BioMCN in the Netherlands has been producing methanol from the CO_2 derived from biosources – specifically glycerine derived indirectly from recycled biodiesel feedstocks – in a commercial facility since early 2008. Carbon Recycling International in Iceland has recently broken ground on the construction of a renewable CO_2-to-methanol first phase industrial scale plant designed for 2 million liters per year of RM from geothermal energy and CO_2, along with renewably produced hydrogen via electrolysis. Methanex is seriously exploring the development of RM commercial pathways. The Palo Alto Research Center is working on the efficient capture of atmospheric CO_2 for RM production which could offer the means of directly recycling atmospheric GHG emissions for liquid fuel production. Such a long term "Holy Grail" may be of profound importance as difficulties and barriers to other GHG strategies such as carbon sequestration become better understood. Commercial-intent demonstration vehicles for port off-road and ultimately on-road applications have attracted serious commercial interest and support from the world's 5th largest containerized shipping company, the nation's largest class 8 engine manufacturer, the nation's 2nd largest port truck OEM, and the world's largest methanol producer.

The long term significance of RM includes its possible use in zero-combustion direct methanol fuel cells (DMFCs) such as those developed by Oorja and commercially deployed by Nissan at their Smyrna, Tennessee facility as replacement for battery powered forklifts. The possible hybridization of RM-fueled DMFC units with on-road battery-equipped vehicles could combine the ease of liquid refueling with zero or near-zero WTW carbon intensity.

The AQIP would be greatly strengthened if it recognized all of these recent developments and opportunities.

Based on the above, there are several important policy findings which should be considered for incorporation into the AQIP:

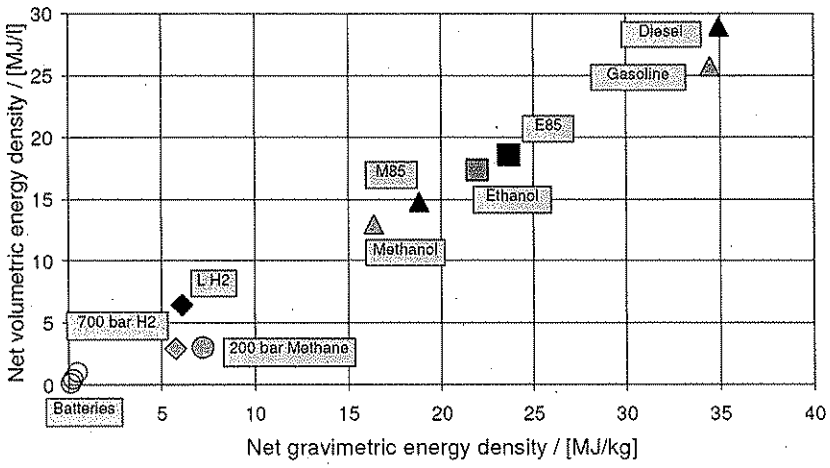
- Renewable Methanol (RM) should be considered a distinct and important alternative fuel pathway, which potentially offers significant GHG reduction benefits compared to more conventional alcohol fuel pathways such as corn-based ethanol.

---

[1] George Olah, Alain Goeppert and G.K. Surya Prakash, "Chemical Recycling of CO_2 to Methanol and Dimethyl Ether: From Greenhouse Gas to Renewably Carbon Neutral Fuels and Synthetic Hydrocarbons", Journal of Chemistry Perspective, American Chemical Society, Volume 74 Number 2, January 16, 2009.

[2] R. J. Pearson and J.W.G. Turner, Lotus Engineering, and M.D. Eisaman and K.A. Littau, Palo Alto Research Center, "Extending the Supply of Alcohol Fuels for Energy Security and Carbon Reduction", SAE # 2009-01-2764, 2009.

- A separate line item should be established for "renewable methanol from CO_2 feed stocks" in the plan to allow for possible resource prioritization.
- If a separate line item for RM is not deemed appropriate, at a minimum, some type of specific category should be created for "renewable fuels from CO_2 feed stocks" which would explicitly include renewable methanol as one of the possible pathways.
- The California Air Resources Board, in coordination with the California Energy Commission, should develop a specific well-to-wheels carbon intensity analysis of RM from CO_2 sources.
- The AQIP should formally recognize the significant near and medium term value of additional non-petroleum sources of liquid alternative fuels, based on their inherently superior volumetric and gravimetric specific energy, as illustrated in the figure below.[3]



- A contingency scenario should be identified which maximizes the development support for liquid alternative fuel options as substitutes for petroleum-derived fuels. Such a contingency plan should be developed as soon as possible in response to the current moratorium on Gulf of Mexico oil production and its possible short, medium, and long term effects on deepwater oil production. It is noteworthy that deepwater sources represent the large majority of current and projected offshore Gulf of Mexico production.

In light of these climate change and energy security factors, there is a strong need to develop a diverse range of alternative fuels. Renewable methanol is one of the options which should be considered seriously for future funding support. It is essential for the Air Resources Board to fully embrace the notion of fuel neutrality by not excluding methanol from explicit consideration. In particular, renewable methanol from CO_2 feed stocks offers important GHG reduction benefits combined with liquid fuel utility and

[3] Ibid, SAE 2009-01-2764.

complete independence from deepwater petroleum resources. This potential should not be ignored by delaying the updating of the AQIP until its next cycle.

At this moment of clarity regarding the unanticipated deleterious effects of petroleum fuel dependency on the Gulf region economy and its fragile ecosystem, it is especially important that ARB reflect on the reasons for such current dependency. The direct value of non-petroleum-based alternative liquid fuels such as renewable methanol can play a significant role in addressing such vulnerabilities. Locking out any reference to renewable methanol in the latest AQIP finalized this year by the Air Resources Board is therefore distinctly not in the state's interest, nor of that of the nation.

We thank the Board for its consideration of these comments.

Sincerely,

Stephen Brueckner

Stephen Brueckner
Chief Technology Officer
Lotus Engineering, Inc.