Sept. 12, 2022

US State Department
ATT Anil Baral
Sacramento, CA

Dear Anil Baral

This letter is being sent in response to the workshop held by CA Air Resources Board on smart agriculture lcfs-wkshp-aug18-ws "Public Workshop to Discuss Potential Changes to the Low Carbon Fuel Standard". The comments reflect several new feedstocks being developed for production of ethanol, biodiesel and renewable diesel & jet fuel and how this could guide decision-making on the envelope for inclusion in GREET modelling and approaches to ILUC. While most of the comments relate to projects occurring overseas, all of the technologies mentioned are feasible in the USA and California and could have significant economic benefits in addition to life cycle carbon reductions.

The main comment is that CARB plays a key role in what occurs in relation to renewable fuels on a global level as a result of work done in coordination with US EPA and evaluation of your program by other countries. This has led to a similar LCFS program in Canada and Brazil and some impact on EU regulations. We congratulate you on that leadership role you have taken to date and will seek in this letter to suggest that this role be expanded to address the global nature of the climate change problem and need to address this problem. This should include setting long-term goals for biofuel blending in parallel with actions by the USA and other countries. We will also comment on assumptions made about several feedstock options that should perhaps be re-evaluated in light of market realities, particularly used cooking oil and what is assumed to be "waste".

<u>Compliance Targets in LCFS and Percentage of Biofuel Blending in Diesel, Gasoline and Jet Fuel:</u>

We believe that the carbon reduction target should be increased to 30% by 2030 and certainly to 30% by 2035 and to 50% by 2040 and this change should be aligned with a similar effort to increase use of renewable fuels on a global basis. This target should cover all fuels including liquid fuels, gaseous fuels and electricity and all transportation sectors. We believe there are available technologies and renewable fuel feedstock to achieve this goal and that setting this goal will generate substantial investment in improving efficiency and achieving zero emission fuels in a broad set of fuel sectors. It is also essential in order to have value of LCFS credits remain reasonable as large volumes of liquid fuels enter the market. In fact, if you can bank LCFS credits past 2030 you could solve the problem of a low value of credits as large volumes of fuels enter the market.

We are well aware of your ZEV program for electric vehicles and applaud all investments in this sector (since I was building production line electric vehicles in 1996-1998 in California). This investment should be balanced, however, with a parallel need to provide large percentage blends of renewable fuels, particularly if these fuels can meet very high carbon reduction goals. Truck and bus conversion to electric will be very costly and infrastructure will require major investments. Medium and heavy duty vehicles could achieve larger reductions in carbon emissions if the fuel blended has much higher blends of biodiesel and HVO diesel in a shorter time frame than currently planned. We also believe that shifts to super low carbon ethanol can justify a much higher blend of ethanol in gasoline and that vehicle companies should be required to offer fully flexible ethanol-gasoline vehicles by 2030 based on an E85 blend and consistent with engine and vehicle manufacturing in Brazil. The cost of a flex-fuel vehicle in Brazil is the same as a gasoline vehicle and the difference in cost to allow use of ethanol is under $25 at a manufacturing level. This would allow for competition at the stations of ethanol and gasoline and sharply reduce gasoline usage starting in 2030. We also believe CARB should indicate that all engines be ethanol compatible starting in 2030 or earlier. Most importantly, the engine timing should be adjusted to optimize the higher octane of ethanol as this would offset the loss of energy density of ethanol. Research by Argonne National Lab has demonstrated that efficiency of vehicles with a 25% blend could be the same with this shift in setting the timing of high compression engines and would provide a much better carbon result from the use of ethanol in gasoline or in flex fuel vehicles.

Phase out of Crop-Based Biofuels or Limits Based on Whether a Crop is Food, Non-Food or Waste:

We are strongly opposed to any limits on crop-based biofuels and believe the trend towards using only waste or non-food crops has done more harm than good. This should instead be replaced with a program incentivizing production of food and fuel as an integrated strategy so that the investment in smart high yield agriculture results in a large surplus of food in the world. First, on the question of food vs. non-food crops, large investments were made in the production of jotropha, momona and other "non-food"crops to align with EU regulations. These investments were not very profitable and many jotropha farms were abandoned. The yields were very low (1 ton of oil or less) and the meal could not be used for animal production so the land not only was not profitable but reduced meal availability for animal production and the policy reduced food availability simply to meet a non-food definition.

With regards to Used Cooking Oil (UCO), we believe this double counting approach to incentivizing UCO in Europe is not logical and has resulted in gross distortions to the lipid markets. UCO is currently more expensive than palm oil and this difference is expected to increase. UCO was fully utilized with some exceptions so using it for fuel did not create a new waste collection system and the only thing that happened was the shift of UCO from other markets to fuel. This is clearly reflected in trade shifts in China where large increases in imports of palm oil occurred in 2019 beyond normal growth and in parallel there was an equally large export of UCO from China to the UK and Europe. Palm oil was then used for substitution in Chinese markets for feed for animals or other applications.   This will only get worse if CARB copies non-food rules of the EU and it will do very little to avoid deforestation.

Putting limits on crop-based fuels make no sense when you have ILUC and Land Use Change worked into the GREET model. We believe the ILUC methodology is flawed and should be re-evaluate not as a broad market impact assessment but instead should be replaced with specific actions taken by countries to preserve jungles and forests. These actions should be encouraged by having California take a lead role in promoting carbon neutral activities by citizens that will utilize carbon credits to preserve jungles. California can then work with countries that place large swaths of jungle into permanent preservation by re-adjusting ILUC assumptions in that country. The reality is that the main driver now for deforestation is not lack of land for agriculture but rather illegal logging and mining. Illegal logging and mining can be addressed by putting a value on forests and providing a strong incentive for countries to preserve these forests. Production of food and fuel is in fact a very effective way to provide alternative employment and should be a development option for countries once they enter into broad agreements for forest preservation.

What CARB can do alternatively is to encourage high yield production of food and fuel as an integrated strategy so that investment occurs in both sectors simultaneously and a large surplus of food is created. Right now most ethanol in California is provided by corn from the USA with an average yield of 11 tons per hectare. Globally average yields of corn are even lower at about 6 tons per hectare. At the same time, there are producers in the USA that are achieving yields of 48 tons per ha. and we have a group we are working with that has achieved 30 tons per ha. from corn planting in Mexico. If all corn production moved to these high yields there would be a huge surplus of corn globally. Even lower yields per ha. are achieved with soybeans at about 4 tons per ha. Yet the ILUC regulations lead to a shift away from use of palm oil and instead HVO plants are being built in California that will use soybean oil at a yield of less than 1 ton of oil per ha. (vs. best yields of 10 tons of oil per ha. for West African palm oil and with macauba). If the LCFS provided strong incentives for achieving high yield in crops, the problems with food availability would not exist as a problem. If you ban food based crops the result will be lower investment in agriculture and less food availability globally.   The emphasis on soybean oil will also mean large amounts of land are used for soybean production vs. use of land involving high lipid per hectare production of very high yield palm or macauba).

This is particularly true when you look at new crops being developed or technology to improve yields of primary crops now in use for biofuel production. We have been working with a group in Brazil that has just undergone field trials that have resulted in yields of sweet potatoes of 60 tons per ha. in the first harvest and 40 tons per ha. in the 2nd harvest for a total of 100 tons per ha. per year.   This results in over 21,000 liters per hectare of ethanol vs. the current yields of corn ethanol per hectare of about 4000 liters per ha. It equally importantly results in 30 tons per ha. of wet residual at 18% protein and can be used as feed combined with vines and leaves of another 20 tons per ha. So the result is 50 tons per ha. of animal feed vs. only 3 tons of feed from soy or 1 ton from corn. If you provide incentives in the LCFS for higher yields of both biofuel and feed for animals, then you will provide a strong incentive to target crop production at crops that provide high yields of both feed and fuel and the food vs. fuel problem would go away.

Integrated Approaches to Production of Ethanol and Meat Using Sweet Potatoes and Sweet Sorghum Rotation:

The most important project we are working on that impacts the LCFS is the sweet potato/sweet sorghum ethanol swine pathway that we believe should provide a model for "food and fuel" instead of food vs. fuel. The project has received funding approval from MAPA and is included in the Plano Safra for Brazil and we expect to start field trials in November, 2022. We have been working with two professors at different Universities in Tocantins and Rio Grande do Sul and EMBRAPA validated field studies have confirmed annual yields of 100 MT per ha. per year as detailed above. We plan on rotating this production annually with some varieties of sorghum from Colombia that have achieved 80 tons per ha. per year of biomass. The availability of large quantities of wet ethanol residual, vines and leaves from the huge volumes of sweet potatoes per ha. has justified integrating hog or swine production. We plan on producing hogs in a co-production effort with ethanol in order to use the feed wet which reduces capital cost and energy use by 28%. The key benefit of hog co-production is that we are able to capture methane from hog production using anaerobic digesters to provide energy for boilers. The LCFS should allow us to get an avoided methane credit since the biogas will be collected by anaerobic digesters and methane collectors in roofs will be used to produce steam and electricity for ethanol production. This is being combined with solar thermal panels and calliandra wood to insure all steam is 100% renewable. We believe the combination of high yield, co-product allocations, methane capture and use of biofuels in transport will result in a net zero emission ethanol production facility. This will be detailed in the submission to CARB of a new pathway for an integrated approach to food and fuel production (we expect to submit a pathway proposal by the end of 2022). However, the yield data on sweet potatoes has already been confirmed by EMBRAPA in Rio Grande do Sul in Brazil so this is not a projected yield but a fully documented achievable yield for sweet potatoes and represents a huge increase in food and fuel availability that justifies this new pathway consideration.

We realize that there is some complexity of methane capture possible from hog production next to the ethanol plant and the resulting methane emissions available for fuel production. We will be setting up an experimental anaerobic digester at the initial pilot scale to evaluate the design details and get data on yields of methane and characteristics of fertilizer once the methane is harvested. This will allow us to estimate the life cycle carbon benefits of the hog integration with both sweet potato farming inputs and energy requirements of the ethanol plant. We will also set up a solar thermal water heating system to measure the top end temperature we can reach when incorporating solar and to experiment with hot water storage for evening steam production to understand how much we can gain from solar in the design. All of this data will be available by the middle of next year and should confirm a zero emission pathway for sweet potato ethanol. Meanwhile, we will use modelling to estimate details of yields of methane and their impact on the life cycle carbon reductions in fuel.

It is also important to mention the very high volume of meat production that results in a large amount of lard for biofuel production. Sweet potato ethanol production can result in sufficient feed to produce about 4 million hogs at 150 Kg each from a 100 million gallon plant. This is 600 million Kg. of whole hogs and 450 milllion Kg. of meat. Out of this meat about 11% is fat or lard. This means one plant produces 50 million kg of fat that can be used for biodiesel or renewable diesel/jet fuel. If 1000 sweet potato ethanol plants are built globally, this results in 100 billion gallons of ethanol and 50 billion kg of lard (50 million tons). This will go a long way to reducing the shortfall of lipids for biofuel use. But it is only possible if CARB drops the idea of excluding lipids that are based on food. In reality, your regulations, when implemented properly, will add 500 million tons of meat to the market and dispel the concept that biofuels are the cause of higher food prices and hunger. This is true if you plant crops that only have yields of 4 to 6 tons like corn and soybeans but it definitely not true when yields reach 100 tons per ha. per year.

Palm Oil
Yield Improvements:
We are working as a consultant to Garuda Prima Energi. We are currently working on doubling the yield on plantations of small farmers in Indonesia where we are improving the net yield of oil from 3.5 tons per ha. to at least 7 tons per ha. and a target of 10 tons of oil per ha. This will be done on a very large scale as it is in connection with 143 oil mills providing 7 million MT of oil for an oil processing complex. The facility will be set up specifically to treat oils in a way that high nutritional value oils will be produced for human consumption and unhealthy oils will be processed used for renewable jet fuel and diesel using HVO (hydrotreated vegetable oil) and for biodiesel production. Yield improvements will occur from better fertilization (sufficient boron, magnesium, right NPK mix, better organic fertilizer that is pre-treated so methane emissions are lower and it is pre-digested and other steps. We will also introduce high yield seeds and replant older trees that are not achieving much oil and all other steps associated with good agronomy. The main reason small farmers have low yields globally is lack of finance. We will finance the farmers so that their yields are increased to 7 to 10 tons of oil per hectare. We will also supervise the whole effort. This will allow us to establish a baseline and achieve yield improvements and changes in life cycle carbon emissions at the farm level and any land use change impacts. We are certain we will get a minimum of 50% and up to 120% yield improvement per hectare of palm production. This is much higher than any normal yield improvements. When it is applied across 143 mills it should result in an additional 7 million MT of palm oil will be created that did not exist before. We plan on producing only 1 million MT of HVO jet fuel and 500,000 MT of biodiesel. So there is 5.5 million MT of new oil entering the market, primarily because of the investment interest in getting jet fuel produced in Indonesia. Most of the biodiesel and renewable jet fuel will be used in Indonesia but some may be shipped to California. We plan on showing yield increases by monitoring the sale of fresh fruit bunches to the mills each year after proper agronomy is applied to the farms and good management practices implemented. We will begin yield improvements immediately as this will give us data on baseline and achieved yields in the study period. In year 2 we will introduce yield improvements on a full commercial stage. By the end of year 3, the HVO refinery will be built, and we will have plenty of data showing all of the palm oil entering in the refining complex is from yield improvements from the participating farms and that none of the baseline volume of palm oil prior to the start of the project is impacted. This should then justify fully eliminating any indirect land use change impact, since the oil is only derived from yield improvements at a farm level.

More importantly in the consideration of food vs. fuel regulation, this example provides justification for rethinking any regulation that simplistically looks at food lipid restrictions. In the project above, we will increase the available palm oil in the market over the next 3-5 years by at least 7 million MT or 10% increase in total available palm oil globally and about a 2% increase on global lipid availability. If all palm oil producers did the same thing, total available palm oil could double and provide 70 million MT of oil for biofuel production without any use of new land for biofuel production. This represents much more oil than demand from any increase in liquid biofuels in California and can be done very cost effectively if there is a clear incentive and financial mechanisms to get smaller farmers to be more efficient and to increase total lipids available in the market.

Macauba and It's Impact on Global Lipid Availability and Issues if Food Vs. Fuel Regulations are Adopted:
The other major consideration in looking at lipids for biofuel is the potential for achieving major increases in oil availability as a result of encouraging tree planting of new oil seed trees. We have done a lot of work on an oil seed tree called macauba in Brazil(macaw palm in USA) and have proposed major tree planting efforts both with the airlines in 2010 and more recently with major biofuel producers. The reason this is being mentioned is that there is the potential to produce massive quantities of lipids that would solve all of your problems with lipid-based biofuels. This can be done with no new land being cleared and will reforest large areas on the edge of the Amazon with a native tree. This is important in looking at smart agriculture, carbon sequestration and reforestation since it would result in a tree cover that will preserve large areas that are now open pasture. The yields of macauba are equivalent to West African palm at about 5 to 6 tons of oil per ha. With better management of harvesting of fruits it should be possible to achieve 10 tons of oil per ha. The trees are very different from West African palm in that the fronds or leaves are much thinner cover so grass can easily grow between trees. This means it is possible to plant trees on large cattle farms that are the most common use of the land now along the edge of the Amazon in Brazil and other countries. This can be done without displacing cattle production, since herds can be shifted to other pasture as the younger trees grow and then be shifted back to the tree planted area on year 4.

This is important in looking at global lipid availability because of the huge area of land in Brazil that is currently in cattle production or other livestock production. There are about 165 million ha. of cattle pasture in Brazil and converting even half of this land to macauba co-production with cattle could provide a minimum of 825 million tons of lipids and up to 1.65 billion tons of lipids annually. The planting of macauba is very cost effective and the oil is exactly like West African palm oil. It is not a new technology or a difficult technical problem. It could easily be done if there is a strong regulatory support for this effort. This is where the regulatory issues come in. On the one hand, you are potentially copying the EU non-food regulatory pathway and are considering excluding food crops. At the same time, you are potentially excluding lipid-based biofuels from your mix of fuels. How you will do this is difficult to say, since you have a lot of lipid based biofuel production in the state. Macauba, even with the potential of adding 1.65 billion tons annually of lipids to the market, is still edible oil. This is good because it will mean an even greater edible meal for cattle and allow for much more efficient cattle production, which will then decrease demand for land for cattle production since more meat will be produced per hectare of grazing land. This is not possible if non-edible fruits are harvested and there is only toxic meal (for example jotropha). Livestock production is expected to double between 2017 and 2050. Using land to grow toxic crops because of market distortions from regulation will only result in serious shortfalls of meat production and higher rates of hunger from lack of livestock.

It is important to understand the volume of production of both higher yields of West African palm through crop efficiency and macauba planting against a backdrop of current global lipid production. Improving yields on 2 million hectares of palm plantations in Indonesia as a result of the Garuda Prima Energi project will result in 7 million tons of new lipids on the market without any increase in planted hectares of West African palm. Trying to get 7 million tons of lipids from soybean oil would require at least 14 million hectares of land, an enormous increase in planted hectares. Yet 7 million tons in only 7 large HVO plants and at least 3 are planned in California alone. Soybean oil is not a sustainable pathway because of the large land use impact but the regulatory fear of deforestation impacts has pushed investors in this direction and many projects in the USA are now being planned around soybean oil as a feedstock. Much better is to get the entire palm industry to reach 8 or 10 tons of oil which would provide an additional 70 million MT of oil. At this level there will be more than enough oil for all of the HVO renewable diesel and jet fuel plants planned.

Macauba is an important as well when looking at global lipid availability. The entire production of oils and fats globally is currently around 200 million MT. Planting macauba trees on half of Brazil's grazing land would increase lipids on the global market by a factor of 8 times from current supplies. This is a huge increase in oils and fats and can only be absorbed by the market if there is a clearly defined market for the oil in biofuel markets. While the oil is the same as palm oil from a technical perspective, no one is going to invest in a new tree type unless it is part of a regulatory scheme for biofuel supplies in conjunction with a global effort to replace diesel fuel. Yet the regulators in the EU have sent the opposite signal to investors that they do not want any investment in any crops for biofuels if they have any food value. CARB should not make the same mistake. In fact, CARB should work with its counterparts at the Ministry of Environment in Brazil and encourage this investment and push the airlines to make these investments so there are lipids available to meet renewable jet fuel goals. We have asked the airlines to invest in tree planting but there was no interest in 2010 and there is unlikely to be now. We have made the same efforts with biofuel companies and they are not willing to make these investments primarily because of the regulatory uncertainty from discussions about limiting biofuel production to non-food pathways.

One alternative to limiting lipid based biofuels is to cap the production to the current level of projects already underway when the rule comes out at the beginning of 2024 but allow for much greater production if the countries provide plans for increasing production of lipids through efficiency improvements on yields in current palm or other plantations or through planting of new tree species. This then provides the incentive for the investment to occur in planting new tree species such as macauba in order to continue and expand use of lipid based biofuels. It also provides a strong incentive to improve yields on current West African palm production, since it is the only way to provide the surplus lipids for biofuel use and is logical from a regulatory and environmental perspective. This can apply to all lipids including other vegetable oils and fats. However, low yield lipids make no sense to plant as they use up a lot of land and do not do much to provide the huge volume of lipids required by biofuel plants.

Yields Based on Average Country Goals vs. Individual or Large Industry Efforts

One problem in CARB current LCFS GREET modelling is that yield improvements are not possible to credit individually and you only use the country average when looking at yields from a crop. This provides no incentive for improvement of the yields, since no credit is provided for higher than average yields. Any changes in the LCFS should change this position in some way that is reasonable for CARB staff to manage. We realize that you need to use an average approach in looking at crops and efficiency of production or you will have to manage yield changes of each farm in your regulation. At the same time, it is difficult to claim there is no oil or biomass for biofuels when yield improvements are left off the table because of this regulatory glitch. What we suggest is that CARB open dialogues with countries that are interested in improving the yields of agriculture substantially and suggest that these yield improvements could be incorporated in rules related to entry of biofuels or feedstocks for biofuel and keep markets open for low carbon fuels in California. At the same time, you could indicate your problems with relying on use of food crops for biofuel if there is not an effort made by countries to improve the efficiency of their production or invest in new super-high yield crops. This would then motivate the countries to initiate pilot projects with innovators within the context of a future national program and you could monitor the efforts of these innovators in crafting rules for entry of feedstock or biofuels from that country. Yield improvements should be more than 3% yield gains that are a normal part of technology development but not so unattainable that no one participates.

We can provide specific examples in our case. The yield improvement program in Indonesia has been crafted in close coordination with the national government. The government is wanting to achieve a high blend percentage of renewable jet fuel through a mandate approach but has to have a producer that can make the investment. Garuda Prima Energi has agreed to make this investment in exchange for access to palm oil for this production. The government then indicated that a large number of coop mills of small producers had oil available. In fact, the land for palm production is currently being re-distributed to small farmers and provides an ideal opportunity to increase yields through investment in new technology and proper agronomic management of existing palm plantations. It would be easy enough for CARB to communicate with the Indonesian government, understand the program, include it in your regulatory process and then encourage the Indonesian government to go from the program on 2 million hectares of farms to include all of the palm production in Indonesia. The result can be an addition of up to 70 million more tons of lipids on the market in the next 5 years that would be available for biodiesel, renewable diesel and renewable jet fuel.

In the case of Brazil sweet potatoes and macauba, we have worked closely with Embrapa, the national research agency. They have verified the yields achieved with sweet potatoes in Rio Grande do Sul of 100 tons per ha. per year. Embrapa has also been instrumental in research on macauba and has developed all of the high yield varieties of trees that should be planted in any commercial program. CARB can simply contact Embrapa, confirm the results were achieved and then initiate a program that encourages this type of high yield agriculture (sweet potatoes rotated with sweet sorghum) or planting of ranch land with macauba.

Methane Capture: We will be instituting a program in all 143 mills of improved treatment of wastewater (palm oil mill effluent) which typically has high methane emission rates from lack of treatment. This will be done using filter presses to remove solids, multiple processes to intensity water treatment, covering of ponds with methane collection systems or dehydration systems to clean and reuse water. Which system and the methane captured will depend on the situation in each mill but we will document all of the emissions prior to making changes and after the systems are implemented. We will use any captured methane for steam production for oil processing of fresh fruit bunches. We will also process empty fruit bunches in a manner that minimizes methane emission generation through management practices, pre-treatment prior to aerobic digestic, anaerobic diegestion or various other methods. These empty fruit bunches, which are currently just dropped off in the field and cause high methane emissions in decomposition, will have much lower emissions in the fields where they are applied and improve yields through organic fertilization. We are wanting to get credit for avoided methane emissions as a result of these various process steps at the mills in managing methane. This could be done by monitoring the changes in one mill and related farms and then duplicating this methodology in all 143 mills involved in the program.

One Option for Limiting Lipids is To Encourage Production of Healthy Oils & Use of Unhealthy Lipids for Biofuel:
An important option to minimize the impact of lipids on global food supply is to use the demand for biofuel lipids to improve the quality of oils and fats that humans consume. If healthy oils can be produced from fractionation of lipids and then unhealthy oils used for biofuel then human health will be improved and there will be lots of unhealthy oils for producing low carbon fuels. For example, we are planning to go through a very specific fractionation process on crude palm oil coming in to capture and use in food by stripping out carotonoids using membrane technology and then using the oil or stearins with no nutritional value for HVO production and infusing the carotonoids back into palm oil food

products so they have 2 or 3 times the level of normal oils. In parallel, we are also fractionating the palm oil into C12 to C16 lipids (about 40% of the oil) that is high saturated fats. High saturated fats are linked to heart disease from high cholesterol levels and other health problems. Pulling this oil from the market is a benefit because it is no longer entering the food market. Equally important, there is the remaining C18-1 lipids, that are about 45% of the original oil, that is now in almost pure form. C18-1 lipids are what is primarily in olive oil and provides high poly-unsaturated fats that are very good for human health. These lipids will be available in large quantities at a low price because there is all of a sudden a market for the high saturated fats to produce biofuels. This will provide much greater nutritional benefits from palm oil use for human consumption and will divert the non-nutritional oil to biofuel production. We believe this would justify a special designation for this palm oil that would allow CARB staff to reduce use of regular lipids while not limiting this category of biofuel production. In any case, the oil will have lower value relative to oil with nutrients in it and the edible oil that is boosted with carotenoids and other micro-nutrients will have more value. So we would like to use a market value based allocation method versus an energy based allocation method for co-products.

<u>Capital Project Costs and Realistic Goal Setting for Renewable Fuel Blends in Liquid Fuels:</u>
The discussion about lipids for biofuel production is important because the cost to build a lipid based renewable diesel or jet fuel plant is about half the cost of building an alcohol to jet fuel pathway and 1/4th the cost of plant using Fischer Tropsch technology for converting municipal waste to fuel. CARB's documents have indicated that you will still have about 25% petroleum based engines in 2045. Between now and 2045 is also a long time and in between the auto, truck, plane and shipping will be run primarily from liquid fuels. Using high blends of renewable fuels in gasoline or diesel is the best way to achieve large reductions in carbon emissions in the next 2 decades. Given the climate crisis on our hands this should not be lightly disregarded to meet some goal of no food crops. While it is still essential to shift to electric vehicles in personal transportation, until this is achieved on a major scale you need to achieve large carbon reductions in fuel. This is particularly important in heavy duty applications, where going electric involves a set of major investments in recharging infrastructure, capital cost hurdles and difficulties when used in interstate trucking.

If you are going to reach a high blend percentage of low carbon fuels in gasoline or diesel it is essential that you not be highly restrictive about what feedstocks and fuels can be used or that blend percentage will never be reached and no carbon reductions will occur. If CARB limits HVO or biodiesel production by limits on lipid utilization or other restrictions, no one is likely to invest in much more expensive alcohol to jet technology or super-expensive waste to biofuel because they will consider regulatory uncertainty in any investment decision and stay away from the sector all together. The result will be no liquid fuels available and no way to reach carbon reductions in transportation except through electric and hydrogen pathways. This presents a very serious problem for aviation, which has no alternative but to use liquid fuels with the exception of electric planes for short flights.

It is important to remember EPA's history with biofuels blending in considering any limits on crop-based biofuels. Their regulations in 2007 setting up the renewable fuel mandate relied heavily on 2nd generation production of biofuels from biomass. Unfortunately, the biomass based ethanol goal was not realized because of the high capital cost of the refinery technology that limited investment. If you restrict production of biofuels to just non-food crops, the result will be very high refining costs and very limited production of biofuels, which will then mean any liquid fuel blending of low carbon fuels will be unreachable. Instead, you need to look at how to focus on improving the yields and productivity of food crop biofuels so less land is needed and more feed is available for more food production.

A specific regulatory solution can involve a two fold pathway. You could cap use of lipids in biodiesel or HVO diesel or jet to existing plants or plants already financed unless a country develops a program to increase yields on existing farm land and implements serious forest preservation efforts. You can also include a category of novel vegetable oils that includes development of lipids that are not now on the market in any meaningful way. This would allow for investment in macauba. This could be encouraged in the same way via promotion of the investment in countries where the tree is native in parallel with efforts to avoid deforestation using land use change calculations. This would not be specific to macauba and could include any native tree planting effort so it would be consistent with LCFS regulations. In parallel, you could encourage airlines and/or HVO project developers to make investments in developing new sources of lipids in exchange for expanding the scope of LCFS to include interstate or international effects.

Agave SUGARS for Ethanol and Renewable Jet Fuel Production

The other major food crop that would be affected by any rule related to restricting biofuels from foods is sugar. Ethanol production in Brazil is almost entirely from sugar cane and has been very successful at achieving high market penetration. 25% blend rates of ethanol in gasoline have already been achieved in combination with 95% of the vehicle fleet being fully flex-fuel. This is being done with an ethanol achieving about 95% carbon reductions on a life cycle basis. This should be a model that CARB uses to increase its use of ethanol in gasoline, instead of trying to keep ethanol blends at 10%. We would suggest in any carbon reduction goal in fuel that you look at incentivizing use of sugar based ethanol in any blends beyond the 10% market share that already exists from corn ethanol. This additional ethanol should only be allowed in gasoline if the ethanol achieves at least a 50% carbon reduction and this should ratchet up.

We realize the main reason CARB is opposed to any blends above 10% because of the impact on VOC's emissions. We believe this problem can be addressed by engine and vehicle technology and controls placed on fuel stations. This risk is more than offset by the benefits of having a much higher blend of ethanol in gasoline that results in immediate and large carbon reductions, particularly if any higher blend requirements are coupled with LCFS and require parallel reductions in carbon intensity of the ethanol used. Higher temperatures from climate change increase VOC emissions much more than the addition of ethanol blends in the fuel.

Important in considering this regulatory issue is the work we are doing with Embrapa in Brazil on an agave validation project. A coop and company in Brazil, GCarbon Brazil and Coop Sisal, have received funding of $600,000 to complete an agave field trial and economic study to confirm it can be grown at a large scale in Brazil. This project is important because EMBRAPA is undertaken a scientific study to validate yields in Brazil. There is already a lot of data from a decade of growing efforts of the agave technology provider. Agave is important because it can be grown in areas with 1 meter of rainfall a year or less and with semi-arid sandy-loam soils. So this makes it feasible to plant in areas that cannot support other agriculture and yet provides huge rewards to farmers and project developers. They also have varieties that are now adapted to cold and can withstand temperatures down to -10 deg. C. Field study results in Australia show a yield of 880 MT after 5 years so this works out to about 180 MT per ha per year. The sugar content is 20-25% so the resulting sugar per hectare is 36-50 tons so ethanol would be half this amount (18-25 tons per ha. per year). This is compared to 14% sugar in cane and yields of 60-100 tons with sugar cane. At 80 tons this is 11 tons of sugar per ha. per year and 6.5 tons of ethanol. So clearly you have a huge difference (3-4 times more ethanol per ha. per year versus sugar cane). This is the low end of the yield with some varieties now at 2000 MT after 5 years. So if you double these numbers that is the high end which is 13 tons of ethanol per hectare per year. This works out to about 35,000 liters per hectare per year or 3,780 gallons per acre per year. By-products of agave processing are fibers that can be used to produce composite parts, which will be in high demand as auto companies seek to lighten cars to meet electric vehicle requirement. Economics of planting agave have come way down, with cost per seedling under $2 now and will be $1.50 by the time a serious planting effort is underway.

The pathways are also important because of carbon sequestration. Agave can sequester between 60 to 100 tons of carbon in the soil per hectare per year. This is in addition to biomass used for ethanol production or fibers for composites or feed for animals. Large scale production of ethanol from agave would result in a large quantity of carbon sequestration that would provide an important mechanism for achieving carbon neutral goals for California companies while providing a pathway to invest in feedstock development of biofuels capacity. It may also be possible to use wastewater after treatment for agave planting that would provide a biological pathway for wastewater treatment and not require utilization of California fresh water resources. It is also important to note that these sequestration levels per hectare per year are much larger than any other crop because up to 5000 plants are planted and they grow slowly with lots of sequestration of carbon in the ground. This compares to very low sequestration rates for traditional crops such as corn where measurements show a small fraction of this soil sequestration effect.

Agave and it Impact on Alcohol to Jet Fuel Pathway:

We are now in serious discussions with Axens and UOP about obtaining alcohol to jet technology for jet fuel. This pathway converts ethanol to jet fuel via dehydration of ethanol to ethylene, dimerization to produce butenes & hexenes and then oligomerization to produce naptha and jet fuel. This provides some benefits over use of HVO pathway in that there are low cost methods to produce sugar and starch from sweet potatoes and agave. This provides a new pathway and agricultural consideration in looking at how California will meet liquid fuel carbon requirements with jet fuel. This is also important because there are opportunities to grow sweet potatoes and agave in California as these technologies develop in other countries that would permit much greater quantities of jet fuel than any other pathways now being explored.

Regulatory Pathway Relevant for Agave Production in California:

Production of agave is feasible in California with new cold tolerant varieties of agave being developed. They can withstand up to -10 C which is not likely to occur in the Imperial Valley where agave is most feasible. What is a problem is water. Agave uses much less water than sugar cane (about 1/3rd of the water) but still needs water. Yet California is providing co-funding to the US EPA to build a wastewater treatment plant in San Ysidro that would send 3 cubic meters per second of fresh water into the ocean unused. We made a specific proposal to both the US EPA and a comment letter to CARB to use this wastewater to grow agave via a reversal of flow of the Tijuana River. We got no comment. This was a serious proposal with all details worked out about how industrial water would be separated and treated, how residential and commercial wastewater would be treated using biological treatment methods and where agave would be grown on land that has almost no vegetative activity. Similar opportunities exist in Mexicali where there is wastewater flowing into California that creates the dirtiest river in the state. This could be solved by the same approach of separating and treating industrial wastewater on site and diverting commercial and residential treatment to facilities that use the treated water for non-food agriculture such as agave to ethanol.

Revision of ILUC Regulations and Their Application to All Fuels

An important comment on ILUC regulations is the lack of correlation of data of cause and effect and the limit of applying ILUC only to crop based agriculture. On the correlation issue, the assumption of ILUC Is that land use change and deforestation are driven by the need for more agricultural land. In fact, the correlation of land ownership in Brazil does not match this assumption. The main driver for deforestation is in fact the value of the logs on the land and the lack of enforcement. This results in clearing of forests to sell the logs or timber or to sell charcoal from the remaining smaller trees. Utilization of this land for agriculture after the clearing has occurred does then occur but has little to do with the original motivation to clear land of timber sales. Studies looking at land ownership of farms in Brazil on land at the edge of the Amazon that was cleared shows the owners of farmland are at least 3 steps removed from the original clearing of the land in about 75% of the cases. This is why the Ministry of Environment in Brazil has not supported ILUC rules and has instead focused on land use change as a regulatory mechanism.

Since deforestation is a major issue and a source of large carbon emissions, we suggest that instead of stricter ILUC rules, you instead enter into dialogues with countries to preserve forests and allow for carbon trading in your consideration of shifts in regulations. While CARB is opposed to getting to low carbon fuels via carbon offsets, they could certainly encourage carbon sequestration via carbon credit programs in areas of high ILUC risk. This would be much more effective than ILUC in getting countries to stop deforestation, particularly if these carbon credits have high value. The link to regulation of fuels is that you are considering restrictions on use of lipids for biofuels and restrictions to non-food crops. This is justified because of a perception that this will preserve forests. In fact it will not because of the correlations above. The best way to address deforestation is to permanently protect from any use that would lead to deforestation.

This then gets to ILUC limitation to crop based agriculture. We believe this is wrong. If you are going to have ILUC, the rules should be expanded to include electric and hydrogen vehicles. You have passed a regulation requiring that all new cars in 2035 be electric. Similar regulations exist in the UK and are being considered in Europe. This will create tremendous demand for nickel, lithium and other precious metals. This will lead to much more mining. Many of the reserves of nickel, lithium and other metals are in intact forests. To extract the ore requires building a road. Building a road in jungles leads to deforestation. That correlation is very clearly established. So your zero emission vehicle policies will have the unintended consequence of increasing deforestation. The solution is to include electric and hydrogen vehicles in any ILUC revision if it is undertaken. Alternatively, you can work with countries and battery producers and make it clear that any sourcing of metals from areas with high deforestation linked to mining will not be allowed if batteries enter into vehicles entering into the California market.

Coordinating Setting of Higher Blend Goals with US EPA and Other Countries:

It is true that California cannot nor should it be responsible for the world's carbon emission reductions. However, it can strongly influence what happens on a global stage by coordinating the setting of its own long term carbon reduction goals with steps in other countries. This is particularly important prior to setting these goals as it may be possible to get other countries to act just on the basis of what CARB thinks it will do and challenging other countries to do the same. We are currently in discussions with Brazil and Indonesia about coordinating an announcement about renewable fuel blending targets in the two countries by 2030. Brazil has already achieved 25% ethanol in gasoline and a fully flex ethanol-gasoline car fleet. It is having difficulty getting past 12% biodiesel, particularly given its reliance on soybean oil as a feedstock. Indonesia has achieved 30% biodiesel in diesel and wants to go to 40% with HVO renewable diesel. Neither country has any renewable jet fuel capacity although Indonesia has mandated 5% renewable fuel by 2025. The two countries have signed a cooperation agreement on renewable fuels and its implementation could lead to the two countries reaching 25-30% renewable fuel in their fuel mix by 2030. Indonesia is starting to get electric scooters but has a high percentage of coal in their electric mix so life cycle benefits are much less than Brazil, which has a lot of hydro capacity. Both countries are looking seriously at renewable jet fuel capacity and will benefit from working together to reach a high blend goal of renewable fuels in gasoline, diesel and jet fuel.

We mention this because the US EPA is supposed to come up with a three year blend goal for biofuels in November, 2022. This is a departure from the 1 year blend goal that is part of the RFS process. This goal setting would be much stronger if it was both a 3 year short term plan and a 25% biofuel blend by 2030. This would result in much greater carbon reductions in other states that are moving slowly on electric vehicle adoption. If this were coordinated with LCFS adoption in other states such as the Midwest or Northeast or New York then even greater carbon reductions could be realized. We believe it is important for CARB and EPA to work together so there is a national carbon reduction program for fuels that is less reliant on actions of the US West Coast.

We also mention this because there is a potential funding mechanism for renewable fuel blending that is occurring as a result of the Ukraine war. The G7 has recently announced that they are going to require ships transporting Russian refined products or crude to regulate a deep discount program on pricing for Russian fuel products. This will be enforced by insurance companies refusing to provide insurance to ships that do not comply. Since UK companies control 95% of the ship insurance business, this is feasible to implement. The opportunity it presents is that there is all of a sudden a windfall reduction in the price of fuel from Russia with a discount that has not been negotiated yet. What could be negotiated is a deep discount that includes an agreement to charge import duties on Russian crude and put these funds in escrow to support low carbon fuel program incentives and implementation of an LCFS approach to lower carbon emissions. Since the discount is a windfall anyway, no one is going to complain if funding is spent on developing alternatives to dependence on petroleum from Russia or any other country in the future. Once the war is over in Ukraine, it will be possible to broaden this program to include all fuels and to use this duty mechanism to insure low carbon fuel programs are implemented around the world. This will then reduce the economic pressure on California to be the market location of choice for low carbon renewable fuels. While this is something the USA will need to get behind not CARB, it is important for CARB to voice interest in an approach that leads to international action on low carbon fuels and that provides a global finance solution. Relying on voluntary transfers of funds from the USA and EU to developing countries is not a long term solution and is derailing agreements on climate change in Egypt in 2022. This program could be announced at the G20 meeting that Indonesia is hosting in November, 2022.

We hope this input is helpful in your analysis of smart agricultural pathways to production of very low or zero carbon biofuels. We are confident that when the GREET modeling is completed and all carbon emissions evaluated, we will achieve zero emissions or lower. We look forward to completing these detailed evaluations and submitting them sometime in 2022 for your further evaluation and comments.

We have provided a power point in the event you want to understand further the technologies involved in yield improvements or the new agricultural crop pathways of sweet potatoes and agave. Their super-high yields relative to corn, sugar cane, wheat or other common means to produce ethanol and similar yield gains with oil to biofuels provide a very efficient means to utilize land, increase food production, reduce carbon emissions and provide a superior zero carbon pathway for California transportation in the future. If you have any questions, please contact me via Whats app 1 786 213 4675 or any of the contact numbers in the presentation.

Sincerely

Bill Wason, President