PURPOSE

The purpose of this document is to request regulatory inclusion of carbon-negative power generation cycles into ARB's existing LCFS program in order to provide a policy more conducive to advancing technologies which offer the potential for true carbon removal. This request comes as ARB is working to incorporate carbon capture and sequestration into California's climate programs and as Clean Energy Systems, Inc. (CES) is developing an advanced oxy-combustion cycle which combines CCS and bioenergy technologies, resulting in net-negative carbon emissions. The suggestions provided herein will create the appropriate economic environment required to deploy carbon-negative cycles on a commercial scale and ultimately surpass the goals set forth in California's current greenhouse gas (GHG) reduction mandates.

BACKGROUND

Clean Energy Systems has developed an advanced carbon-negative power cycle, called BioCCS, capable of producing electricity, renewable natural gas (RNG, or biomethane), and/or hydrogen, all of which may be used as alternative transportation fuels. The feedstock to the BioCCS system is woody biomass waste which has absorbed carbon dioxide (CO_2) – a known GHG – over its lifetime. When this waste is disposed using traditional methods, such as natural decomposition or burning in conventional biomass power plants, GHGs are released back into the air in the form of CO_2 or methane, as well as other pollutants. Using this feedstock as a fuel, the BioCCS cycle captures and sequesters the absorbed CO_2 while producing clean electricity (see schematic below); notice there is no exhaust stack required.

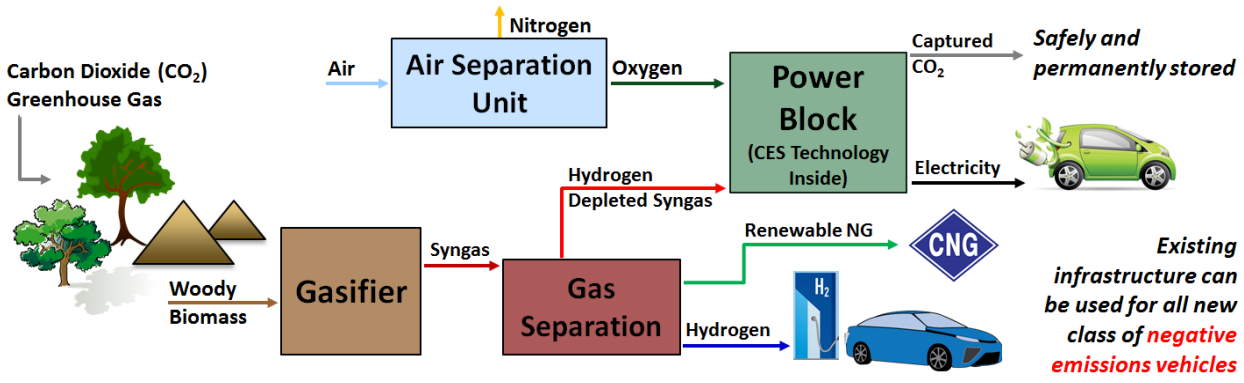

Figure 1: Simplified Schematic of CES' BioCCS Cycle

REQUESTED REGULATORY UPDATES

While the BioCCS cycle offers an effective method for truly removing CO_2 from the atmosphere with the added benefit of producing a useful product (e.g. electricity), deployment has thus far been constrained.

This is in part, due to regulations focused too narrowly on particular requirements rather than promoting any solution to the challenge of producing energy with a lower (in this case, a negative) carbon footprint. CES requests that an amendment be made to the LCFS regulations to allow for indirect allocation of credits for electricity generated with a carbon intensity value of less than zero. A cap may be placed on this indirect allocation, possibly calculated by the amount of electric vehicle (EV) charging required in the state (based on the number of EVs) minus the electricity and associated credits allocated by other program participants and renewable energy production methods (public charging stations, home solar, etc.), along with other factors as-determined by ARB.

RATIONALE

Current wording in the regulation requires direct coupling of a generation source with the charging facility, inherently preventing the utility-scale deployment of negative-carbon power plants required for California to reach our de-carbonization goals in the transportation sector. In reference to the aforementioned indirect allocation cap, over 300,000 EVs have been sold in California[1], requiring *over 1,400 GWh* of power for vehicle charging per year. This is a significant amount of power that can be generated using carbon-negative cycles if that electricity is eligible for indirect generation of LCFS credits. While a portion of this power is generated via renewable resources, and after accounting for charging station operators and other entities are generating the associated credits, there is a significant portion of power fueling EVs which is generated via carbon-emitting fossil fuel-based methods that could instead be produced using net-negative carbon cycles.

While any carbon capture cycle is inherently more capital intensive than traditional systems, power market pricing and LCFS credit trading prices make BioCCS cycles competitive with conventional fossil fuel power plants as well as with solar and wind facilities, both of which come with their own challenges (weather-dependent, effects on the duck curve, etc.). The requested modification to the LCFS regulations will allow for the required economics to garner the private investment needed to deploy a series of carbon-negative power plants throughout California and remove over 1.25 metric tons of CO_2 per MWh generated. With each 1% market penetration, BioCCS technology will *remove* over 3.5 million metric tons of CO_2 from the atmosphere every year while also displacing fossil fuel-based power, *preventing an additional* 2 million metric tons per year from being released, as well as a reduction in all other criteria pollutants.

ADDITIONAL ARGUMENTS

Net-negative carbon cycles offer lower carbon intensities than the existing and planned LCFS pathways, yet they are currently ineligible under the existing regulation due to the "real-world" operational requirements, while less-effective, net-positive carbon cycles are eligible. Just because these other cycles fit nicely within the existing regulation does not mean they're the best solution. For example, RNG produced from biomass resources and used in the transportation sector, while better than fossil fuels, still ultimately releases all of the carbon previously stored by the biomass as it is burned in a combustion

engine. And while biomethane demand in California is high and is a viable solution to GHG reduction, its use is not nearly as effective as net-negative electricity cycles. As any project must maintain economic viability in order to progress, this is currently driving CES to pursue the development of facilities that produce RNG. Simply put, using CES' process as an example, not allowing indirect allocation of net-negative cycles by replacing some fossil-based electricity capacity will result in the deployment of a series of facilities that actually pollute rather than remove GHGs. These facilities will pollute less than their fossil-based contemporaries, but it is certainly not the goal of ARB to disqualify climate change mitigation solutions which are significantly better than other eligible technologies simply because they do not fit nicely within a specific regulatory framework.

Electricity produced via net-negative carbon cycles and sent to the grid also displaces power which would have been generated using fossil fuels and has better environmental attributes than wind and solar technologies. With the goal of reaching 1.5 million ZEVs on California's roads by 2025[1], there will be the cumulative electrical demand to allow for multiple large-scale (~25-50 MWe) BioCCS power production facilities, displacing power generated from traditional fossil fuel facilities. As an example, if the average EV uses 35 kWh/100 miles, and the average distance traveled per year per driver in California is 13,500 miles, assuming 50% of the zero-emissions vehicles on the road by 2025 are traditional EVs, this translates to over 3,540 GWh/year of carbon-negative power, effectively *removing* 4.44 million metric tons of CO_2 from the atmosphere while avoiding an *additional* 2.49 million metric tons from being released. With this assumption, a fleet of 500 to 1,000 MWe of BioCCS plants will offer the most impactful carbon reduction plan to meet the state's objectives. Removing GHGs is better than simply not emitting additional pollutants (as in a zero-emission cycles), and is obviously much better than cycles which simply reduce the amount of GHGs emitted when compared to a fossil fuel baseline.

Additionally, EV vehicles require at least 20-30 minutes to draw a useful charge using the latest commercially available technology. Utility-scale facilities cannot and should not be located at sites where the general public must wait for their vehicles to charge due to safety and security concerns; this is why charging stations are located at extended parking and entertainment areas such as airports and shopping malls. The challenge under the existing system, then, is to allow for carbon-negative cycle plants to functionally or virtually deliver electricity to multiple sites for vehicle charging. CES is aware of current discussions to treat electricity similar to biomethane, allowing for the physical decoupling of the production and charging facilities. However, such a situation constitutes electrical wheeling which is prohibited by current CPUC regulations. So although ARB may eventually permit it, it would still be prohibited due to the CPUC's regulations.

CONCLUSION

Carbon-negative cycles are a solution to the challenge of actually removing existing GHGs, not simply reducing emissions, and provide a pathway for California to meet the current and future GHG emission

[1] http://www.energy.ca.gov/renewables/tracking_progress/documents/electric_vehicle.pdf

reduction targets. The intent of this document is to provide an argument for adopting new language in the LCFS regulation to provide considerations for cycles which exceed the spirit of the mandate. It is CES' opinion that net-negative carbon cycles providing electricity, while removing and preventing the release of harmful GHGs into the atmosphere, should be a prime focus in California, regardless of how that electricity is utilized. We agree stipulations must be followed, and as such, have suggested modifications to provide a path for relaxing the current preconditions to allow for more effective solutions to climate change challenges while also maintaining the overarching framework by keeping within the transportation sector.

QUESTIONS/CONTACT INFORMATION

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General information on CES' BioCCS cycle may be found at: www.cleanenergysystems.com/bioccs/