Dated: August 8, 2014

Algenol Biofuels Inc. Comments to Florida Public Service Commission on 2014 U.S. EPA Proposed Carbon Pollution Standard for Existing Stationary Sources

Thank you for the opportunity to provide comments and input regarding the development of the State of Florida's approach to addressing and complying with the U.S. Environmental Protection Agency's (EPA) Proposed "Clean Power Plan" to reduce greenhouse gas emissions as to existing stationary sources. These comments are submitted by Algenol Biofuels Inc. (Algenol), a leading biofuels company based in Ft. Myers, Florida, which has developed and is advancing the large-scale commercialization of Algenol's unique algae-to-fuels.

Algenol is keenly interested in this topic as we continue our march towards commercializing Algenol's Direct to Ethanol® technology, an algae-based process for economically producing biofuels that has at least a 60% reduction in greenhouse gas (GHG) emissions compared to traditional gasoline. Algenol is actively seeking to secure the capital required to build our first commercial scale project in Florida, for which site evaluation and other activities are already underway. Algenol plans to invest over $1.3 billion through four phases and our ability to execute this project is reliant on the ability to secure an industrial source of carbon dioxide, which is the feedstock for our enhanced algae. Reducing and recycling carbon is perhaps the greatest challenge of a generation, and Algenol offers an elegant and profitable technology that can play a central role in meeting this challenge while also domestically producing environmentally friendly, affordable fuels. Algenol is preparing comments to EPA, addressed below, in which we plan to state and make the case that it is imperative that EPA also include carbon capture and utilization (CCU) in the rule as an appropriate, highly effective means to address reducing GHG emissions. Doing so will provide the impetus for utilities and other emitters to recognize and embrace CCU at this critical juncture in the evolution of a technology with enormous environmental and economic benefits.

While EPA has chosen thus far to not explicitly include CCU in the proposed rule, it is important to note that EPA gives states significant latitude to implement and meet state-level emission reduction targets. As such, the State of Florida has an opportunity to embrace a technology that has been fostered and demonstrated in Fort Myers. Algenol continues to operate and expand its pilot-scale integrated biorefinery there, and, on a parallel path is engaged with utilities, land owners, engineering firms and others to build its first commercial facility in Florida. That project is intended to provide the basis for rapid deployment of the technology in suitable locations in other states. Florida has an opportunity to embrace a homegrown technology with massive potential and emerge as a leader in beneficially utilizing the CO_2.

Following is additional information regarding Algenol's technology along with draft comments that we are preparing for submission to EPA.

Direct to Ethanol® Technology

Algenol's patented technology enables the production of the four most important transportation fuels (ethanol, gasoline, diesel, and jet fuel) for around $1.30 per gallon each using proprietary algae, sunlight, carbon dioxide and saltwater at production levels of 8,000 total gallons of liquid fuel per acre per year. In a two-step process, we first produce ethanol directly from the algae utilizing our Direct to Ethanol® technology and second, a bio-crude through hydrothermal liquefaction conversion of the spent algae once the ethanol production process is complete. Algenol's technology produces high yields and relies on patented photobioreactors, proprietary separations, and processing techniques for low-cost fuels production. These novel, low-cost techniques have the added benefit of consuming carbon dioxide from industrial sources, not using farmland or food crops, and being able to provide more freshwater than fuels produced. We are actively evaluating sites, meeting with industrial CO_2 providers, establishing engineering designs and pursuing permitting for a first, large commercial project.

Algenol has been in business for 8 years and has invested over $250 million in our technology. While we may be a relative newcomer in the biofuels industry, we are also very confident that we will emerge as a leader in meeting the GHG reduction goals in EPA's Clean Power Plan and the renewable fuel obligations detailed in the federal Renewable Fuel Standard (RFS). We are commercializing a breakthrough algae-based technology. Algenol's focus is currently concentrated in two areas. First, continuing to operate and build out additional acreage at our pilot-scale facility in Ft. Myersthat is currently converting CO_2 into fuels. On a parallel path, as noted above, we are actively engaged with landholders, CO_2 emitters and others to execute a first commercial project for a technology that can be replicated in several other suitable locations in the United States.

Primary comment: The draft rule is too timid, and should include Carbon Capture and Utilization (CCU)

We generally agree with the flexible, statebased approach and the specific standards and emission levels set by the EPA for the states under the Clean Air Act section 111 (d) authority. However, we believe that the timeline is far too extended to stimulate critical early development activities, and the technology recommendations too timid. The draft rule may drive marginal dispatching rule changes, reinforce the move toward natural gas and lock in marginal energy efficiency and renewable energy gains, but it will not drive the bold technology investments needed to make a difference in this nation's power generation assets, and ultimately in global emissions. While EPA proposed four distinct approaches[1] for the states to reduce emissions from their power generation sector and left much flexibility to the individual states, it is obvious that its major impact will be to reinforce the already

[1]Heat rate improvements, fuel switching, increase renewable energy and energy efficiency, and grid strategies.

occurring shift from coal generation to natural gas combined cycle (NGCC) generation. EPA was also surprisingly not prescriptive of many emission control technology options for Emission Generating Units (EGUs), but they did mention partial Carbon Capture and Sequestration (CCS) even though they largely discarded the option and its potential application later in the document. CCU did not even make it in the discussion. At a minimum, Algenol would like to see the rule language include CCU as a low-cost, feasible, legitimate pathway for the states to meet their goals.

Just as the rule for new power plant emissions, this rule may also be used as a blueprint not just for states but a partial blueprint by foreign countries and international funding bodies and may yield enormous indirect impact, since China and India alone have 720 operating coal-fired power plants[2] and plan to bring online 818 new coal-fired power plants over the next decade or so[3]. Since most of these plants will be built, it is essential that they be coupled with technology that can cost effectively lower their carbon emissions. Otherwise the world will lock in huge carbon increases for the next 50 years. CCU is an attractive pathway that meets the needs of developing countries to afford cheap power for their economic development and population, health, and welfare. As a result, we believe CCU should be highly visible in the rule, preferably as its own "block" of strategies available to the states.

Major Comments on the draft EPA rule

- As an endemic problem of the draft rule, none of the rule language or the recommended four blocks focuses on bold technology and market-based solutions to reduce greenhouse gases at the source. Even basic options such as fuel switching are not included and the reference to nuclear energy is not exactly an example of a bold climate "moonshot", e.g. slow-down decommissioning of nuclear plants.
- Solutions that involve capturing carbon at the source do not fit neatly in any of the blocks proposed by the EPA. It would be preferable if a fifth block catalyzed the states to facilitate market-based carbon capture and utilization solutions wherever they make sense. Not only that, long-term numerical targets, such as those for renewable energy, would help trigger a huge wave of investment. CCU would allow utilities and their business partners to sell CO2 in various specifications within a wide range of prices up to $35-$40/tonne.
- EPA has set up goals for 2030, and has asked the states to develop average interim goals for the 2020-2029 period. We believe that this delays progress too far in the future to trigger utility investments early on. EPA should consider a more explicit "ratcheting up" method within shorter time intervals to reflect technology evolution driving down the cost of solutions.
- EPA can't have it both ways. On one hand EPA is painfully cautious, presumably to allow the states to work from existing state policies and investment trends. On the other hand, the timeline for plans and progress is incredibly stretched. Thus, we wonder why it does not call for more sustainable and transformational remedies, such as CCU.

[2] http://online.wsj.com/articles/india-runs-short-on-coal-despite-global-price-slump-1407139782; http://www.thegwpf.org/china-india-building-4-coal-power-plants-week/

[3] World Resource Institute, November 2012.

- The general thrust should be to encourage carbon capture investments by including profitable CO2 end use with net carbon benefits in the overall target emission limits. As a result, the carbon capture investments would not have to be supported by the rate base, and would be easy for utilities to justify.
- Even though utilizing carbon for enhanced oil recovery (EOR) can be characterized as CCS, it involves the marketable use of CO2 for a profitable endeavor. Per the EPA rule and position on new power plants, there was a CO2 market of 60 million tonnes per year for EOR applications. CCU is consistent with and indeed should include EOR applications, and as well as beneficial reuse for conversion into a wide array of fuels and products, including algae-to-fuels processes.
- Algenol aims to convert 1 metric ton of CO2 into 144 gallons of fuels. Algenol's first commercial plant will target initial construction in 2015, and will involve a utility partner as a supplier of CO2. If our technology was fully applied to emissions from 67 coal fired power plants, Algenol could meet 15% of the US fuel needs. There is clearly a role for technology such as ours to play in helping existing and new fossil fuel power plants minimize carbon pollution and meet EPA GHG objectives.

EPA's draft rule still references carbon sequestration, which remains plagued by economic, financial, engineering, geological, legal and regulatory challenges. Algenol can provide a powerful alternative to sequestration, as discussed in the next section.

Specific comments on draft rule language

pp.33-34: The four building blocks proposed by EPA do not make room for control technologies that address the problem at the source, a fairly rare occurrence within the Clean Air Act. Instead, the EPA resorts to four indirect solutions, including generator efficiency improvements, substituting natural gas combined cycle generation, substituting renewable energy or using demand-side energy efficiency to reduce emissions. To repeat, we advocate for the addition of language that would include capturing carbon economically and utilizing and monetizing this carbon through beneficial solutions such as fuels, chemicals or building materials. EPA should recognize the full value of carbon offsets created by these carbon utilization solutions.

p. 48, 398: After noting that climate change is an urgent problem and setting up reasonable targets (26% to 30% by 2030), EPA establishes elongated deadlines for states to submit final plans: June 2016, 2017, or 2018, depending of the approach selected. Not only that, states need only begin to achieve GHG reductions by 2020, and only need to meet an interim performance level based on their 2020-2029 period average. This means states can backload most of their gains to the end of the next decade without running into compliance issues. This will not create a climate of investment in solutions anytime soon, especially given the numerous political changes that will undoubtedly occur in Washington during that period.

Page 94: "Model Rule on interstate emissions credit trading and price ceiling." We would like this approach to be developed and fully vetted prior to the final rule. We particularly like the concept of "alternative compliance payments" that facilities could use whenever their compliance costs exceeded

the level of this compliance payment. This would create state-based clean technology funds that could then be directed to projects that reduce carbon pollution in these states. This model rule could be up and running within a year, and we see no reason to wait until 2020 for this rule to be issued.

Page 95: "Power plant-specific assessment". We also like the concept of a plant-specific assessment to be considered, and broadened from an "inside the fence" concept to "near the fence" concept. This way, a plant would need to consider what can be done internally and nearby, such as capturing and shipping the CO2 to an adjacent algae facility, prior to being able to use emission trading or other "outside the fence" concepts.

Page 137: "Like stakeholders, we are attentive to the need to maintain electricity system reliability, and to minimize adverse impacts on electricity and fuel prices…"

Algenol totally supports these objectives and believes that its technology will help achieve these goals. By capturing CO2 from existing coal or gas-fired plants, we will help maintain total system reliability, and our ability to pay for the CO2 will ensure that there is minimal impact on electricity prices.

Page 144: "Nevertheless, CCS would be available to states and sources as a compliance option." We do not believe that this statement is correct. The geological, legal and technology challenges of CO2 storage are too pervasive for CCS to be a broadly applied solution within the next few decades. We highly encourage EPA to consult with the U.S. Department of Energy (DOE) Fossil Energy Office and National Energy Technology Laboratory experts and obtain their latest assessment of the concept, as well as their view on CCU. The DOE Fossil Energy Office has funded $1 billion worth of CCU projects through the Recovery Act and their expertise should be substantially included and further taken into consideration in EPA's analyses than it is in the proposed rule.

Pages 148, 152, 189: Discussions of carbon avoidance costs. EPA calculates that the cost to substitute electricity from an existing NGCC unit from an average coal-fired steam EGU would be approximately $30/ton. The cost of switching more generation to renewable energy and delaying nuclear plant retirements would range between $10 and $40/tonne, while demand-side energy efficiency programs would range between $16 and $24/tonne. The cost of CCS has been assessed in the past to be at least $80/tonne. These costs will all be borne by ratepayers, consumers and/or utility shareholders. While Algenol can secure carbon at costs ranging between $1 and $40 per tonne, we will absorb the costs because our fuels can be sold at a value of more than $400/tonne of CO2 utilized. Since the fuel produced by Algenol is cheaper to produce than alternative options, it means that there will be net positive benefits to consumers and utility shareholders.

Page 202-203: "State RE Generation Levels for State Goal". We like this approach and think it could be broadened to other solution spaces. If EPA insists on deadlines far in the future, it could perhaps be bolder and look for the development of small, but growing numerical goals for carbon capture and re-use. The investment impact of these goals would lead to an explosion of technology investment and innovation. The current EPA "let's ride the fracking boom" approach does little to promote the sort of investments needed broadly on the state, national, and international level to solve the climate change problem at the source.

Page 425: Criteria for Approving State Plans

Algenol makes the point that CCU would be fully consistent with all the criteria to approve state plans: (1) Enforceable measures. (2) Emission performance. (3) Quantifiable and Verifiable. (4) Reporting and Corrective actions. Given that CCU in the form of an Algenol facility is a point source solution with hard assets on the ground, and a full array of control and monitoring equipment, the states should have no difficulties in fitting CCU targets or incentives within an overall GHG state plan that needs to meet EPA muster.

Page 526: Resources for States to Consider in Developing their Plans

Just like states desired resources to account for energy efficiency and renewable energy use in state plans, EPA could also volunteer to develop clear methodologies, tools and metrics to measure CCU policies and programs, so they can be included as part of their compliance strategies.

CO_2 Utilization in Biofuels versus Carbon Capture and Sequestration

Algenol's Direct to Ethanol® biorefinery concept can yield ethanol with a carbon footprint that is less than 20% of that for gasoline.[4] The biorefinery concept of Sapphire Energy, Inc., another U.S. algae/biofuels company, can yield a carbon footprint that is about 30% that of gasoline according to a recent publication.[5] It is useful to consider the integration of biofuel technologies with power plants in order to make a comparison to carbon capture and sequestration (CCS) and test what footprint reduction level is required to yield equivalent CO_2 reduction to CCS. The analysis first considers integration with a pulverized coal-fired power plant[6] and is then extended to three other cases (Natural Gas, IGCC, and Supercritical). The captured CO_2 is consumed within the Algenol biorefinery with the produced ethanol utilized as a liquid transportation fuel. This analysis considers the parasitic load of typical liquid amine capture systems and the resulting increase in CO_2 production/power consumption as a result of the capture station. The parasitic load is assumed to be proportional to the CO_2 emission level for the different power plants.

The basis for the carbon footprint calculation is: 1 MWh of net produced electricity from the pulverized coal-fired power plant (2100 lb CO_2/MWh)[7] with the captured CO_2 (capture efficiency=90%) delivered to a co-located Algenol facility for conversion into biofuel. With assumptions indicated in Figure 1, this

[4] **Luo, D., et al.,** "Life cycle energy and greenhouse gas emissions for an ethanol production process based on blue-green algae", *Environmental Science & Technology*, **44**(22), pp. 8670-8677, (2010).

[5] **Liu, X., et al.,** "Pilot-scale data provide enhanced estimates of the life cycle energy and emissions profile of algae biofuels produced via hydrothermal liquefaction"*, Bioresource Technology*, **148**, pp. 163-171, (2013).

[6] **Luo, D**., "Design of highly distributed biofuel production systems", Ph.D. Thesis, Georgia Institute of Technology, (2011). **Lively, R., et al.,** "Anthropogenic CO2 as a feedstock for the production of algal-based biofuels, Biofuels, Bioproducts, and Biorefining, DOI:10.1002/bbb.1505 (2014).

[7] **Rubin, E. S. et al.**, "Comparative assessments of fossil fuel power plants with CO_2 capture and storage". Presented at *International Conference on Greenhouse Gas Control Technol., Vol. 1*. Vancouver, Canada (2004).

yields an additional 4.16 MWh of transportation fuel (thermal) energy with an overall release of approximately 3335 lb of CO_2, about 2360 lbs originating from the combustion of the ethanol. As a reference, in the current status quo (no capture, no biofuel), 1 MWh of electricity from pulverized coal and 4.16 MWh of thermal energy from gasoline would produce approximately 5274 lb of CO_2. Furthermore, if CO_2 is captured (20% parasitic load, capture efficiency=90%) and sequestered (10% additional parasitic load for compression and storage) then the overall CO_2 released will be approximately 3535 lb of CO_2 (assuming 4.16 MWh of thermal energy from gasoline). This demonstrates that, in terms of overall carbon footprint, an Algenol biorefinery has major advantages over the status quo and is fully competitive with CCS.

Similar calculations for natural gas (810 lb CO_2/MWh), IGCC (1450 lb CO_2/MWh), and Supercritical (1675 lb CO_2/MWh)[8] yield the same conclusion, i.e., that an Algenol biorefinery facility can yield significant CO_2 reduction benefits equal to or slightly better than CCS. To compare these four types of power plants on a consistent basis, carbon footprint per MWh delivered to wheels (in a vehicle) were computed. For this, 'fuel-to-wheels' efficiencies are assumed as 60% and 20% for electric and gasoline/ethanol fueled vehicle respectively. The results are summarized in Figure 2.

To address biofuels more generally, the break-even point for CO_2 utilization in a biofuel versus CCS comparison is a footprint of 23% compared to gasoline for all four power plant scenarios considered. The Algenol case is 17% but can range from 12-27% depending on specific conditions. The Sapphire case[9] at 30% would be slightly disadvantaged with respect to CCS, as would a fuel that just met the RFS standard of a 60% reduction. However, the avoidance of risks and other uncertainties associated with underground storage must also be considered.

[8] **Rubin, E. S. et al.**, "Comparative assessments of fossil fuel power plants with CO_2 capture and storage". Presented at *International Conference on Greenhouse Gas Control Technol., Vol. 1*. Vancouver, Canada (2004).
Environmental Protection Agency, "Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units", Proposed Rule (2013).

[9] **Liu, X., et al.,** "Pilot-scale data provide enhanced estimates of the life cycle energy and emissions profile of algae biofuels produced via hydrothermal liquefaction"*, Bioresource Technology*, **148**, pp. 163-171, (2013).

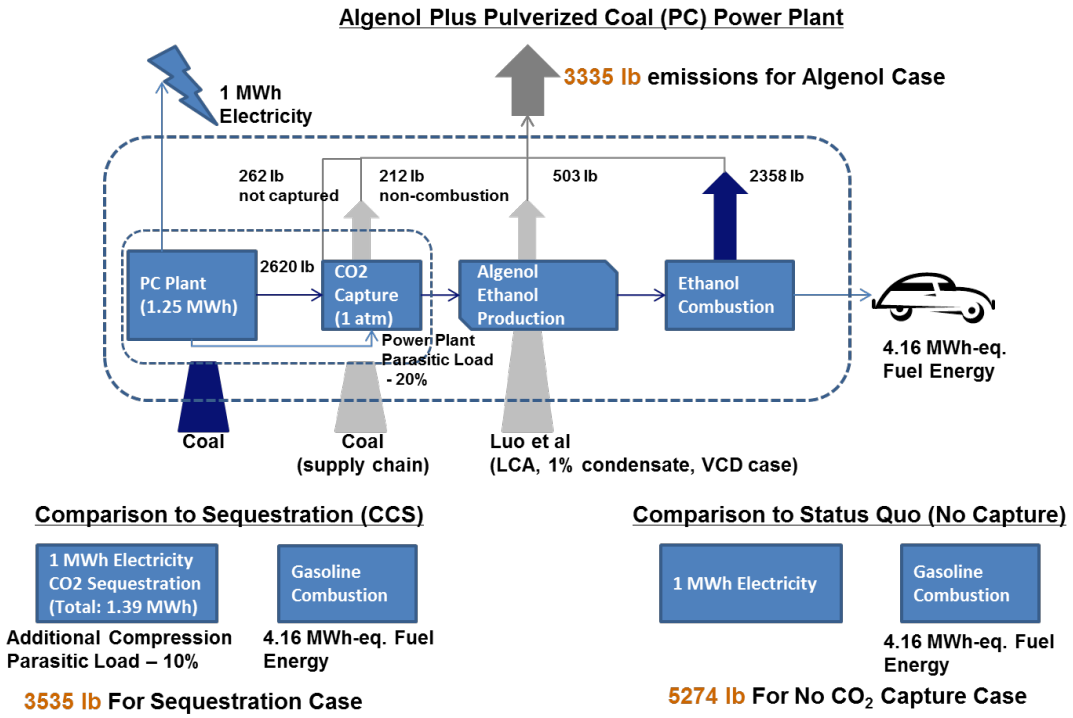

Figure 1: Carbon Footprint: Direct to Ethanol® advantaged vs. CCS and greatly advantaged vs. *status quo* for pulverized coal-fired power plant. Similar results obtained for natural gas, IGCC, and supercritical plants.

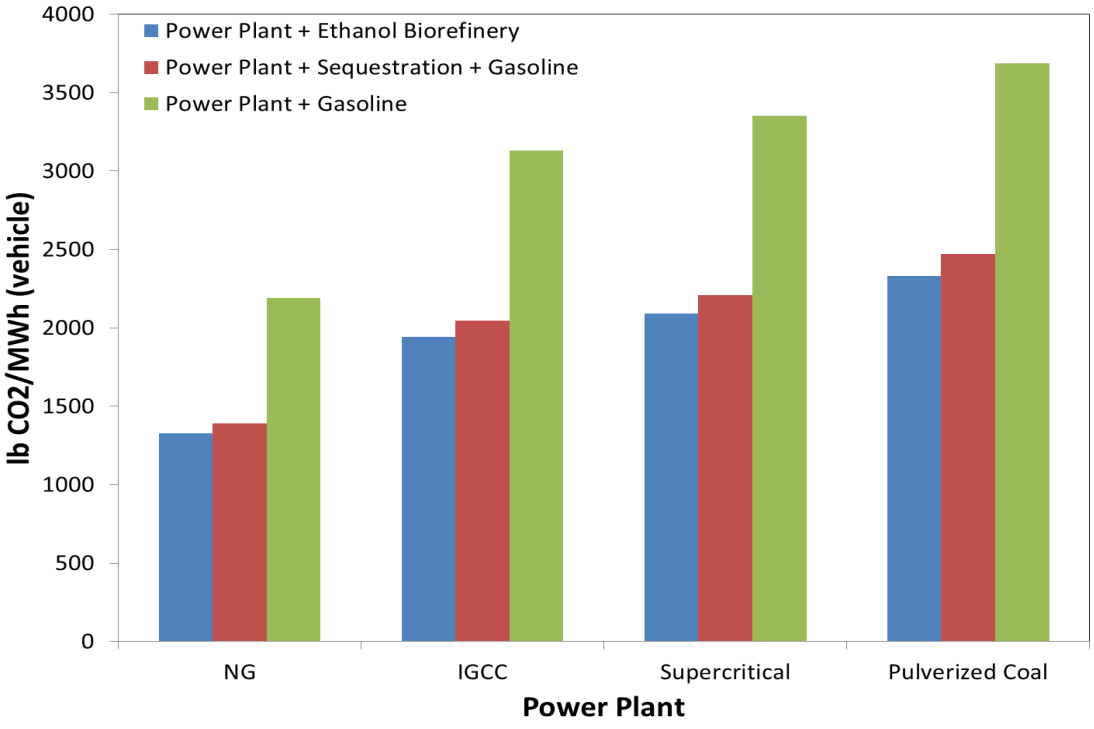

Figure 2: CO_2 emissions for an Algenol facility integrated with four different power plant scenarios in comparison to carbon capture and sequestration (CCS) and status quo (no capture). The above analysis, carried out by scientists at the Georgia Institute of Technology and Algenol Biofuels, has been published in a peer-reviewed publication.[10]

Crucial role that Algenol and Carbon Capture and Utilization can play

Algenol has demonstrated an ability to utilize our enhanced algae to convert CO_2 into fuels. Policy support that will provide the encouragement for utilities to seriously engage with Algenol and others is an important factor for commercialization. In addition to Algenol's project, DOE has helped to advance CO_2 reuse nationally by funding projects that are currently demonstrating carbon utilization. It is an approach for reducing emissions that must be encouraged, if not demanded, by EPA.

We are concerned and it is troubling that the proposed rule includes a discussion of carbon capture and sequestration that ignores utilization. Carbon capture and utilization would achieve the same desired result of reduced emissions but would do so in an economical way that, at least in Algenol's instance, simultaneously produces a valuable product. In no uncertain terms, carbon capture and sequestration is an economical loser and poses environmental risks that are not fully understood, which are likely the main reasons that it has not been embraced or effectively demonstrated to date. By staying silent on utilization options, EPA is effectively advancing a preference for sequestration, which could slow Algenol's commercialization efforts to utilize and monetize CO_2 emissions. EPA is missing a significant opportunity. Also, the proposed rule's use of "Permanent storage" of CO_2 is a euphemism for disposal, which runs counter to the Pollution Prevention Act's waste management hierarchy in which disposal is the least preferred option for handling waste. We encourage the EPA to apply this hierarchy to CO_2 and encourage the utilization of CO_2 as a preferred method to sequestration. Even when subsequently combusted as a transportation fuel, CO_2 utilization produces meaningful emissions reductions by displacing additional fossil fuel combustion, not to mention meeting the goals of the federal Renewable Fuel Standard. Every barrel of Algenol's fuel produced through carbon capture and utilization replaces a barrel of petroleum that would otherwise have been extracted and combusted. Through this substitution, carbon remains stored underground as petroleum.

Critically, EPA has an opportunity to help establish a market for captured carbon and carbon utilization can mitigate, offset, or even negate the cost of carbon capture, providing an emissions reduction mechanism that minimizes the cost to ratepayers. Algenol has repeatedly stated its intent to pay utilities for their CO_2.

In light of Algenol's and others' ability to capture and utilize carbon emissions, it is difficult to understand how EPA could ignore this opportunity to encourage such transformational technologies. EPA's mission should be to advocate, encourage and codify policies to responsibly reduce emissions, and utilization must be a key part of those efforts. We would be happy to address these topics further as

[10] **Lively, R., et al.,** "Anthropogenic CO2 as a feedstock for the production of algal-based biofuels, Biofuels, Bioproducts, and Biorefining, DOI:10.1002/bbb.1505 (2014).

part of Florida's evaluation and development of these issues and response to the draft rule and to address how carbon utilization can play an important role in mitigating GHG emissions in Florida. We appreciate the opportunity to submit these comments.