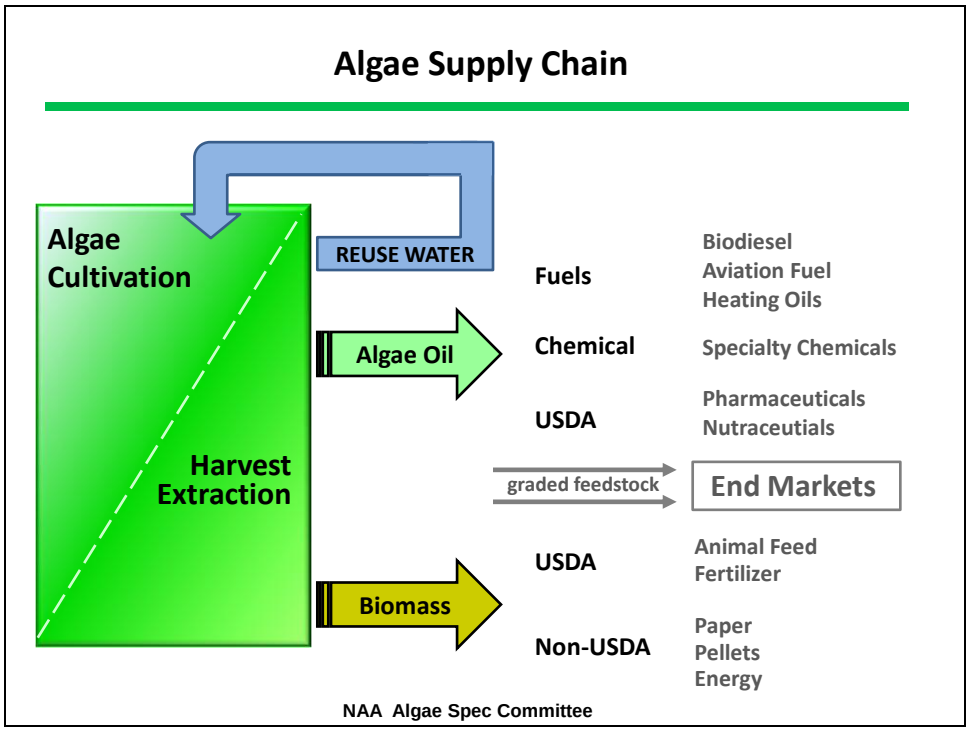
# NAA Algae Oil & Biomass White Paper

It is our understanding that DOE/USDA and the Biomass Initiative are considering issuing solicitations to accelerate the growth at scale of micro algal biomass in order to make large amounts of biomass available for downstream players to convert into fuels, energy and value-added products at a large pilot scale. We would applaud such an initiative; however we wish to help make sure that this laudable program be focused in a practical and viable manner. The intent of this white paper is to offer guidance as to the form in which algal biomass and also algal oil be delivered to the emerging algae industry.




Algae strains are selected for desired properties which best support end market processing needs. Various cultivation technologies exist to grow the algae to required density. The Algae is harvested and extracted, separating the algae into three products:

a) Water – nutrient rich water is reclaimed for next grow cycle
b) Algal Oil – feedstock to multiple end-markets
c) Algal Biomass - feedstock to multiple end-markets

Cultivation and harvest/extraction are best co-located (or near-located), to provide efficiency of cost and time. The algal oil and algal biomass are the transferable products for which the preferred quality properties are discussed. Water is reused, and is not desired in transferred products.

It is an undisputed fact that of all biomass on Earth, aquatic species are the most prolific growers. Indeed, while aquatic species account for only 3% of the biomass on the planet, they contribute fully 55% of the photosynthesis on Earth. Hence aquatic species are orders of magnitude better candidates than their terrestrial (land-based) brethren, to replace fossil fuels and provide us with a sustainable solution to the World's energy and chemical needs. Of all aquatic species, microalgae are far and away the champions in terms of biomass production and energy potential.

However, the state of commercialization of algae to energy is lagging behind that of their much less efficient terrestrial biomass producing counterparts. This has lead to debates which question the viability of microalgae as a real candidate for green energy, and have steered some to the shorter term potential of "proven" land crops. This in turn could influence the funding agencies to line up in the same way leaving unexplored the most prolific contender of high yield renewable green energy.

This raises the question **"Why is micro algae being viewed as a low priority candidate in the race for fossil oil replacement?"** In our opinion, there is a one word answer to this question: "Water!" The very attribute that makes these aquatic species so spectacular in performance also hampers their transition commercial production. Farming of algae (upstream in the oil industry vernacular) is a solvable problem and many of the solutions are already developed in practice and ready to go, in part, to research funding from the Federal agencies. It is the subsequent steps (midstream) of microalgae harvesting, dewatering, extraction, fractionation and conversion into streams suitable for conversion (downstream) using the existing infrastructure into final consumer products (such as fuels, energy, nutraceutials and chemicals) that have been neglected in the race to move the microalgae solution forward.

We support the predicted drive by DOE and USDA to move microalgae to the next level, by making algal biomass/feed stocks available on a large (tons per annum) scale to downstream companies. By getting substantive amounts of these products into the hands of the downstream industry will level the playing field with terrestrial biomass, and only then will microalgae have their opportunity to outperform their terrestrial counterparts. However there is an apparent issue and that issue is **Water**.

Just producing algae is insufficient to advance this energy solution. Production algae, depending whether it is produced in fermenters (F), photo bioreactors (P) or open ponds (O), contains 80% (F) to 98% (P) to 99.9% (O) water. Cost of production decreases while energy potential increases in that order. This association was lead to believe there are intentions to research distributions with biomass in aqueous form. At commercial scale, and even pilot and demonstration we argue that it is not economical to develop processes based on distribution of algal products containing 80 - 99.9% water.

Here are the key points supporting our position:

**a) Corrosion**

For this emerging industry to succeed in the shortest period with minimal capital investments, it must be compatible with existing distribution infrastructure. However, water is a corrosive agent to the existing infrastructure, especially with the pH levels used in algae production. There are water level specifications and limits in pipelines and facilities to manage this corrosive effect.

**b) Decomposition**

It is a known fact that biomass containing greater than 20% water will ferment and decompose during transport and storage unless refrigeration is used. Refrigeration is a significant cost burden while rendering the algae feedstock less valuable. In our opinion the high cost barriers of refrigerated shipping of wet algal biomass are prohibitive even at pilot and demonstration scale.

**c) Efficiency**

The conversion of algal feedstocks to end-market products is greatly reduced or even inoperative with significant amounts of water. Many processes consider water a contaminant. End-markets do not want water in their feedstock. As a reference, many fuel processes require <0.1% moisture feedstock.

**d) Quality Measures**

Laboratory test methods see moisture as an interference, which masks the true value of the product being testing.

**e) Commerce**

End-markets view moisture as a contaminate, moisture reduces product value and penalties are standard within the existing industries to reject on receipt or apply pre-negotiated price compensation for reduced product value

Our humble suggestion is that the funding agencies focus and give preference to micro algal production facilities that are integrated and can deliver either dry biomass or algal oils – or preferably both. Both of these materials can be shipped around the country cost-effectively by bulk road or rail shipping, as are today's commodity products, to the downstream recipients to study at their pilot or demonstration facility. Simply stated, the existing infrastructure to handle, ship and inspect oil and biomass of other industries are well defined. **The basic algal products (algal oil and algal biomass) fit within the existing infrastructure of transport, handling, commerce and controls.**

From an environmental view, water extracted from the harvested algae is reused to increase efficiencies and Green House Gas (GHG) correctness. The water is nutrient rich and applied to the next grow cycle. Minimal make-up water is required to sustain closed system cultivation. Transport

of non-value “water contaminant” is eliminated, as is the associated negative GHG metrics (transporting water and removal on receipt is not GHG friendly).

Federally funded “off-take agreements” to produce viable algal products in ton quantities for the nascent renewable energy industry will be the most cost-effective use of money, which will serve the entire algae-to-products value chain very well and potentially expediting the pathway to fuel-scale implementation.

*Note: The National Algae Association (NAA) and the NAA Algal Spec Committee represent a diverse industry and academic background, defining the guidelines for algal product specifications for quality and commerce. The committee shares concern and insight of issues that moisture will cause. The Committee further believes that Algal products (oil & biomass) can and should be managed within existing infrastructure of transports, handling, measures and commerce.*