C. Meghan Starbuck
Oral Testimony
November 29, 2010

The New Mexico State Legislature
Science, Technology, and Telecommunications Committee

Mr. Chairman and Members of the Committee:

Good Afternoon. My name is Meghan Starbuck. I am an Assistant Professor of Economics at New Mexico State University, and life-long resident of New Mexico. I graduated from New Mexico State University (NMSU), completed my Ph.D. in Economics from the University of New Mexico, and now I am fortunate enough to work for my Alma Mater, NMSU. Since 2006, I have been researching the economics of renewable energy in New Mexico. I am currently the Economics Director for the National Alliance for Advanced Biofuels and Bioproducts, a US Department of Energy funded consortium

designed to help drive algal biofuels to commercialization. I will be referencing the material in the handouts provided to you throughout my prepared statement, but it is supplementary information.

New Mexico State University is an active partner in the drive towards algal fuel commercialization, and works closely with numerous partners within the state and around the country. Our research program in algal fuels spans four colleges (Agriculture, Arts and Sciences, Business, and Engineering), and our Artesia Agricultural Experiment Station. Our key algal biofuels researchers are: Shuguang Deng, Nirmal Khandan, Adrian Unc, Wayne Van Voorhies, Shanna Ivey, Tanner Schaub, Weibke Boeing, Luz Elena Mimbela, Abbas Ghassemmi, and Pete Lammers. We have formal and informal research collaborations in New Mexico with: Los Alamos National Labs,

Sandia National Labs, Sapphire Energy Inc., and the Center of Excellence for Hazardous Materials Management. New Mexico State University is also collaborating with the following National Lab and Academic partners from around the Country: Pacific Northwest National Labs, Argonne National Labs, University of Arizona, Arizona State University, Colorado State University, Texas A&M University, and University of Central Florida. Our inter-disciplinary team of researchers at NMSU is focused on helping to address the key challenges related to the development of commercially viable algal based biofuels, and developing the industry in New Mexico.

New Mexico State University is currently involved with two major algal biofuels projects (the National Alliance for Advanced Biofuels and Bioproducts -- a $44 million US DOE project; and a project for the Air Force Research Laboratory -- a

$2.5 million project focusing on aviation fuels). NMSU is also the lead institution on a $45 million proposal to the US Department of Agriculture to research algal biofuels. We have other highly competitive proposals submitted to the National Science Foundation, and to a combined US Department of Agriculture and US Department of Energy funding opportunity. The funded research currently underway at NMSU is helping provide critical monies for hiring staff, students, and purchasing research equipment. Our success in this area is important for helping to serve New Mexicans and help foster a new path for sustainable economic development in our state. Money spent on research in New Mexico provides funds for hiring and training the workforce needed to create new jobs and new opportunities for all New Mexicans.

There is a need for economic development in New Mexico, especially in rural areas. The state needs more jobs and better paying jobs. We need to have economic opportunities for our graduates from our high schools and our universities. The state needs to develop new industries and new types of jobs. The industries and employment that we should seek to create should be non-exportable to lower-wage countries like Indonesia, Vietnam, South Africa, and other upcoming Asian and African countries. The United States, and New Mexico, is in need of industries that are capable of using the vast resource base, both physical and human, to create world-class technologies and industries. Algal biofuels for New Mexico offers the possibility of creating the type of tangible, home-grown, products and technologies, and industries that will be the basis of sustainable long-term growth.

Algal biofuels are a hi-tech agricultural energy industry. Employment in this industry will be comprised of workers that are skilled and unskilled. The algal biofuels industry will need highly trained technicians in biology, chemistry, and engineering, as well as workers skilled in construction, transportation, agriculture, and energy. Given the historic basis of the New Mexico economy in agriculture and energy production, algal biofuels are capable of re-invigorating these sectors. The promise of algal biofuels is in the ability to use the current infrastructure (i.e., fungible) and provide a very high quality, energy dense fuel. Algal based fuels are not 'green compromises' such as ethanol or biodiesel, but true advanced fuels that are capable of fueling our military vehicles and aircraft as well as providing commercial aviation and civilian transportation fuels. Algal biocrude is chemically similar to

petroleum based crude and researchers are finding the same chemical structures and materials in algal crude as they do in petroleum. This provides an exciting opportunity and a new way of looking at energy production in the US and New Mexico.

By being able to grow our fuels, we can create exportable technology -- but not exportable jobs; all while using fewer resources than other bioenergy crops. Algae are highly efficient photosynthetic organisms that require CO_2 to grow, and providing this CO_2 can result in significant greenhouse gas emission reductions compared to traditional transportation fuels. [Handout Page # 4]. Other environmental benefits associated with algae, and not associated with other biofuel crops, are related to the use of non-agricultural resources used in production. Brackish waters, marginal rangeland, waste nutrients, and captured CO_2 sources are the key environmental

inputs required. This implies that the production of algal crude will not compete with current agricultural resources. [Handout Page #5]. For New Mexico this is key. New Mexico is a largely rural state with lots of sunshine, flat open expanses of land, and extensive brackish aquifers. Additionally, New Mexico has extensive energy and agricultural infrastructure that the nascent algal energy industry could use for vital production inputs. The knowledge, skills, training, and employment base currently employed in the agricultural and oil and gas sectors, combined with companies like Sapphire Energy Inc., New Mexico State University, Santa Fe Community College, and the National Labs (Sandia and Los Alamos) provide key competitive advantages over most other places in the world. New Mexico is a state that is at the forefront of a very competitive global development push.

The economic impacts to the state of New Mexico from an algal fuel industry have the potential to be significant. [Handout Page #6]. While highly uncertain at this early developmental stage, we can provide some guidance as to the economic impacts that might be derived from the industry. Using a standard Input-Output software package (REMI PI+) the impacts from 100 million gallons of algal crude production were estimated. Based on current production models from CEHMM and Sapphire, the number of employees needed to operate a given size facility were used in the oil and gas extraction sector in REMI to simulate the potential impact on New Mexico. [Handout Page # 7, 8, 9]. Based on current scale up plans, it is estimated that the number of jobs engaged directly in algal oil production will be 44 in the year 2012 and 76 jobs by the year 2020, based on a single 100 million gallon per year algal facility.

[Handout Page #11]. The first 100 million gallons of algal crude can potentially generate an additional 452 total (direct, indirect, induced) jobs in New Mexico, with an additional $8,000,000 in state tax revenues -- per 100 million gallons per year produced. This is exclusive of any refining and distribution impacts that might accrue as a result of production. [Handout Page # 12, 13].

If New Mexico is successful in producing algal crude at scale, and is successful at capturing significant market share, than the economic impacts to the state become more significant. If New Mexico can capture 10% of the upcoming Renewable Fuel Standard (21 Billion Gallons by 2022), then New Mexico could see as much as 1,596 jobs in direct employment with a total (direct, indirect, induced) employment level of 12,729. The increase in Gross State Product could be

$483 million, and as much as $91 million in increased state tax revenues. If New Mexico could capture 30% of the Renewable Fuel Standard than total employment could reach approximately 27,000 and tax revenues could be in excess of $200 million. Currently (as of 2007) the oil and gas extraction sector has an employment level of around 8,000. Thus, if successful, an algal fuel industry represents an important path forward for New Mexico. [Handout Page #14].

Thus far, I have painted a rosy picture for algal biocrude and the state of New Mexico. However, there are numerous barriers and pitfalls that could negate any of the potential benefits associated with algal crude production for New Mexico and the United States. While the basic science (first principles) behind algal based fuel are sound and well-established, there are significant barriers that could prevent the promise from

being achieved. Three key barriers exist: (1) technical; (2) economic; and (3) policy. The technical and economic barriers, have "technical solutions", i.e., they are solvable. Policy remains a stubborn problem that can easily prevent sustainable economic development in algal fuels (and other leading edge technologies).

Key technical barriers, that continued research *will* solve, are associated with so-called 'crop protection', increasing yields, quality control, product mix, low-cost harvesting, process scale-up, and logistics. The economic barriers are derived from the technical barriers and are a function of solving the production *process* in a low-cost, resource-minimizing system. Given sufficient revenue streams (and the potential of developing/capturing) these revenue streams, the technical-economic barriers are likely solvable.

What of the policy barrier, then? Often times policy and other 'human derived' barriers have no technical solution and can prove to be the most intractable. In the state of New Mexico, there are several key policy issues related to the development of a thriving biofuel industry. Establishing a regulatory framework in conjunction with industry and scientific experts is critical. This framework should be developed as soon as possible, and should be based on the unique features of hi-tech agricultural energy production. Analog industries might appear to be the oil and gas industry, or the dairy industry, but applying the regulatory and legal framework from these industries to algal production pose significant cost and compliance issues that can be detrimental to the developing industry. These are currently imposing undue costs with little to no demonstrated benefit to New Mexicans

or the environment, and comes at a very high and very *critical time cost.* In this globally competitive industry, where progress and change is marked in months (not years), regulatory delays mean that the industry will move to other states and countries, and we will lose our competitive advantage. The state of New Mexico needs to be proactive in creating regulatory and legal frameworks ***for*** the algae industry. If the state of New Mexico can work to develop regulatory standards and rules in conjunction ***with*** industry we can stay at the forefront of global development. From the interactions with industry and government that I have had the good fortune to experience, I can state that environmental regulation is a go/no-go criterion for investors in New Mexico. Given the competitive advantage New Mexico currently has, it is important to be a ***creator of*** the

national (and even global) environmental regulation for advanced biofuels.

In Conclusion, if New Mexico can fully capitalize on the unique confluence of natural resources, human talent, economic conditions, and political will -- then New Mexico can be the lead in a wave of domestic sustainable economic development. New Mexico can create a new industry that produces fungible transportation fuels for the United States and around the world. Fuels that are low-carbon, produced here in New Mexico, and that generate jobs and economic prosperity for the long-term.

Thank you. I would be happy to answer any questions.