

## **BIOALGAL: Algae for Energy - Algal Cultivation and Extraction Research**

**Location:** New Mexico State University, Main Campus

**Project supervisors:** Shuguang Deng (Chemical Engineering) and Omar Holguin (Energy Research Laboratory), New Mexico State University



Biofuels extracted and processed from cultivated algae hold promise as a renewable source of hydrocarbons. However, many details regarding the large-scale cultivation of algae and the extraction and characterization of the resulting biomass need further research. Drs. Deng and Holguin are looking for undergraduate students to help with research in those areas this summer.

Students will work with Dr. Holguin's research group to work on algae cultivation at the outdoor cultivation test bed at Fabian Garcia Science Center immediately adjacent to the main campus at NMSU. The cultivation of algae will take place in both laboratory settings and in closed photobioreactors under field conditions. Students will also work with Dr. Deng's group to carry out experiments on hydrothermal processing of algae in a laboratory environment.

### **During this project, students will:**

- Help cultivate algae in a variety of conditions
- Help develop and test a variety of biofuel extraction and characterization techniques

### **Students must have completed the following courses to be eligible to participate in this project:**

- General Chemistry, Physics, and Biology
- Biochemistry and Organic Chemistry (preferred)

### **Students interested in these majors should consider this project:**

- Chemical Engineering and other Engineering majors (B.S.)
- Chemistry, Mathematics, and Biology (A.S., B.A., B.S.)
- Science and Pre-engineering (A.S.)

**Students involved in this project will work at the main campus of New Mexico State University in Las Cruces and at the nearby Fabian Garcia Agricultural Science Station. Housing in the NMSU dorms will be provided.**

## **BIOALGAL: Spectral Effects on Photosynthetic Water Use Efficiency**

**Location:** University of New Mexico, Main Campus

**Project Supervisors:** David Hanson (Department of Biology)

Scientists in Biology Department in the College of Arts and Sciences are currently pursuing ways to use light emitting diodes (LEDs) to improve the productivity of photosynthetic organisms, especially relating to water use. Plants use some wavelengths for photosynthesis, while others signal developmental processes or cause other responses, such as light opening of stomatal pores in leaves (to let carbon dioxide in and water out). In addition, infrared lights cause heating of leaves that can lead to stress.



Innovations in LED technology now make wavelength tuning and other lighting arrangements possible and economically beneficial. These advances are also making indoor agriculture feasible on large scales, offering additional strategies for improving the carbon for water balance in the generation of bioproducts.

We are interested in expanding this area of research to define the limits and advantages of spectral tuning for maximizing productivity while minimizing water use. We are seeking students who are highly motivated to conduct innovative and industry-relevant research in this area.

### **During this project, students will:**

- Use cutting edge instrumentation
- Make connections with industry partners
- Compare water loss and carbon capture across species and environmental conditions
- Measure photosynthesis
- Use LEDs to alter spectra for growth of photosynthetic organisms
- Learn basic biochemistry

### **Students must have completed the following courses to be eligible to participate in this project:**

- Introductory Biology or Biology for Engineers

### **Students interested in these majors should consider this project:**

- Biology (A.S., B.A. or B.S.)
- Science (A.S.)
- Pre-engineering (A.S.)
- Engineering (B.S.)

**Students involved in this project will live and work on the main campus of the University of New Mexico in Albuquerque. Housing in the UNM dorms will be provided.**

## **Osmotic Power Development: Acquiring Energy from Waste Water**

**Locations:** New Mexico Institute of Mining and Technology (New Mexico Tech)

**Project supervisors:** Frank Huang (NMT Environmental Engineering), Qiang Wei (NMHU Chemistry, Trevi Systems Inc.), Yongming Tian (NMT Environmental Engineering)

In 2007, New Mexico generated 28 billion gallons of produced water from oil and gas production with a significant portion (~44%) being disposed of as a waste via underground injection. Although osmotic pressure has been observed for centuries, it was never used to harness energy using produced water as the sources. One of the critical areas of developing osmotic power using highly saline produced water is membrane fabrication and characterization. The selected students will participate in the dry-jet wet spinning of hollow fiber membranes (HFMs), the characterization of the HFMs, including DMA, DSC, SEM, salt rejection, water flux, S factor, and bursting pressure, the construction of HFM modules, and the testing of the modules in the pressure-retarded osmosis (PRO) system to determine the sustainable energy densities.

### **During this project, students will:**

1. Fabricate and analyze polymeric membrane materials via wet-chemistry method
2. Learn and apply advanced characterization techniques to correlate structure and properties relationship of advanced membrane materials for osmotic power development
3. Practice real-time problem-solving skills through several cutting edge projects including module design and construction, fiber spinning extrusion, PRO testing

### **Students should have completed the following courses to be eligible to participate in this project:**

Organic and Polymer Chemistry

Thermodynamics and Kinetics (preferred)

Fundamentals of Mechanical Engineering

### **Students interested in these majors should consider this project:**

Chemical Engineering, Mechanical Engineering, Environmental Engineering, Chemistry, Materials Engineering (A.S., B.A., B.S.)

**Students involved in this project will work at New Mexico Tech in Socorro. Housing in the NMT dorms will be provided.**

## **SOCIAL/SCIENCE NEXUS: New Mexico's Energy/Water Future - Attitudes and Preferences Towards Energy Production**

**Location:** University of New Mexico, Main Campus

**Project Supervisors:** Janie M. Chermak and Jennifer Thacher (Department of Economics)

Energy and water scarcity are often linked problems and expanding human activity that is increasing demand for both is a challenge to managing these resources. Choices between energy and water are often considered from the physical science perspective. However, resource management policies must consider social acceptance of those policies in order to gain support. Given the diverse energy resources available in the state, the importance of the fossil fuel industry to the state, and our scarce water resources, the attitudes and preferences of New Mexicans is critically important. This work focuses on gathering and analyzing preferences and attitudes towards energy production and water use.



Students participating in the Social Natural Science Nexus will take part in the administration of a statewide energy/water survey. They will gain experience in data gathering, management, analysis, and data reporting. In addition, they will participate in developing effective tools to disseminate the data to a diverse audience. From this they will gain knowledge in the potential impact improved information and societal attitudes can play in resource use.

### **During this project, students will:**

- Gain experience in data management from data entry to cleaning
- Conduct literature reviews
- Conduct data analysis and interpretation
- Complete a poster project from their work for presentation

### **It is preferable that students have completed the following:**

- Introductory statistics or econometrics
- Introductory microeconomics

### **Students interested in these majors should consider this project:**

- Economics (A.S., B.A., B.S.)
- Statistics (A.S., B.A., B.S.)
- Political Science (A.S., B.A., B.S.)
- Environmental Studies (A.S., B.A., B.S.)

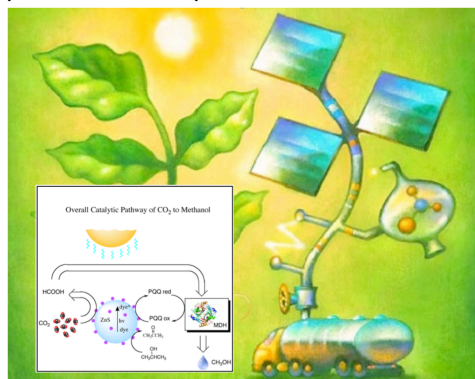
**Students with strong writing skills, experience with Excel, and familiarity with a statistics package (SAS, STATA, NLOGIT) are preferred.**



## SOLAR: Photons to Fuels and Feedstocks: Solar Energy in New Mexico

**Locations:** New Mexico Tech, University of New Mexico, Main Campus and New Mexico State University  
**Project supervisors:** [Michael Heagy](#) (NMT Chemistry) and [Martin Kirk](#), [Yang Qing](#), and [John Grey](#) (UNM Chemistry) Hongmei Luo (NMSU Chemical Engineering)

Solar energy is an important type of renewable energy. However, the initial cost of silicon based solar panels is either prohibitive or not well-suited for a variety of applications. This primary goal of this project is to synthesize and test new, non-silicon molecules and materials for the collection of energy from sunlight. For example, zinc sulfide crystals coated with light absorbing organic dyes might be able to convert CO<sub>2</sub> to methanol (see the figure to the left).



Students participating in the solar energy team will take part in several cutting edge projects involving spectroscopy, photochemistry, and synthesis in organometallic, inorganic, and polymer chemistry. In all cases, our team will utilize a multidisciplinary approach to accomplish our goals, and

students associated with the project will make new materials be involved in determining key photo, magnetic and electrical features of these new systems. Weekly or biweekly meetings with project group members will enhance student learning by tackling research problems, giving oral presentations, and learning the theoretical basis of the research being performed in solar team laboratories. Social events within each team are also anticipated to promote team spirit and these will promote informal discussions between students and the PIs.

### During this project, students will:

- Synthesize and characterize new molecules and materials
- Learn and apply advanced spectroscopy techniques
- Learn and apply advanced magnetic techniques

### Students must have completed the following courses to be eligible to participate in this project:

- General Chemistry I and II
- Organic Chemistry I and II
- Physical Chemistry I and II (preferred)

### Students interested in these majors should consider this project:

- Chemistry, Physics, Optics, Biology, and/or Chemical Engineering (A.S., B.A., B.S.)
- Science and Pre-engineering (A.S.)

**Students involved in this project will work both at New Mexico Tech in Socorro and on the main campus of The University of New Mexico in Albuquerque. Housing in the NMT and UNM dorms will be provided.**

## **URANIUM: Assessing Uranium Contamination on Navajo and Laguna tribal lands**

**Locations:** NMT, Laguna Pueblo, Navajo Nation

**Project Supervisors:** Dan Cadol (NMT Earth Science), Gayan Rubasinghe (NMT Chemistry), Bonnie Frey (New Mexico Bureau of Geology)

Tribal lands, such as those of the Navajo Nation and Laguna Pueblo, contain many closed and/or abandoned uranium mines. The remaining waste material poses a potential hazard to the citizens of these areas, through contamination of groundwater, soil and dust. While some cleanup of these sites is either underway or completed, many sites remain a concern for local communities.



Contaminated soil and sediment can be transported by water, wind, plants and humans. The key to containing and remediating affected soil, sediment and water is to understand transport rates and accumulation sites. For example, vegetation may slow the wind and cause contaminated dust to settle. Likewise, some plants incorporate dissolved uranium taken up through their roots into their tissues. Human health can be affected by inhaling or ingesting contaminated material. Students will examine accumulation and transport processes in the landscape and the human health effects by dust inhalation.



### **During this project, students will:**

- Research the history and impact of uranium mining and interact with local community members
- Collect and preserve well water, soil and / or dust samples
- Prepare dust samples for analysis to determine uranium concentration and simulate interactions with bodily fluids
- Analyze samples for uranium and other toxic elements
- Report analysis results back to local communities

### **Students must have completed the following courses to be eligible to participate in this project:**

- General Chemistry
- Navajo and Laguna students will be given preferred consideration for this project.

### **Students interested in these majors should consider this project:**

- Chemistry (B.A., B.S.)
- Environmental Science (A.A.S., A.S., A.A., B.S., B.A.)
- Science and Pre-engineering (A.S.)
- Geosciences (B.A., B.S.)

**Participants will likely work on Navajo tribal lands and Laguna Pueblo and at New Mexico Tech in Socorro, with travel and outdoor work required. Housing will be provided. Past participants have**

**presented results at conferences including the New Mexico Academy of Science Research Symposium, the American Indian Science and Engineering Society, and the New Mexico Geological Society.**