**PROJECT TITLE**: Western States Algae Bioproducts and Biotechnology Initiative

**STATEMENT OF ISSUE AND JUSTIFICATION**: During a technology roadmap workshop in December 2008 sponsored by the U.S. Department of Energy (DOE), discussions by industry, academic, and national lab partners suggested that development of algal biofuels will require coordination and support of fundamental research, infrastructure development, technology deployment, and information management at various governmental levels. Algae are ‘green’ micro-factories that produce valuable compounds in sufficient quantities to be economically viable and useful for food, fuel, medicines and chemical production. Interest in algae as a feedstock is driven by algae’s high potential yield per acre, by far the greatest potential of any feedstock for conversion to biofuels, its adaptability to a wide variety of environmental and climatic growth conditions, and its ability to be cultivated on marginal land unsuitable for growing crops or raising livestock. However, production cost estimates (net of capital costs) for growing and converting algae to bioproducts, especially fuel, are significantly higher than for first- and next-generation biofuels.

The primary goal of the proposed Western States Algae Biotechnology and Biofuels Initiative (Initiative) is to develop a new generation of bioproducts, including liquid transportation fuels, using environmentally benign and sustainable technologies for production, harvesting, and processing of algae, through interdisciplinary, collaborative efforts among multiple institutions around the region and the nation.

**TYPES OF ACTIVITIES**: The Initiative would integrate a broad spectrum of disciplines with a shared objective of rapidly developing a comprehensive strategy for using algae as a new source for food, energy and other valuable chemical entities. This would effectively make algae a new agricultural specialty crop which would not compete with existing human food crops for arable land or an alternative usage of valuable and limited human foodstuffs. Next generation biofuels and bioproducts from feedstocks such as algae provide an opportunity to leverage the diverse climate, lengthy coast line, extensive arid high deserts, and plentiful solar and wind resources, as well as geothermal sources available in the West.

The Institute would address significant global environmental concerns. The potential for carbon sequestration and or direct use of atmospheric CO2 to reduce greenhouse gas burden on the earth’s atmosphere by algae mediated carbon fixation would also be a major focus and contribution of this initiative. Similarly, algae based energy production could generate liquid fuels with a greatly reduced global carbon footprint. The availability of potable water is a major concern to much of the planets population, due in part to insufficient waste water treatment and contamination of surface and sometimes subsurface water supplies. The potential for comparatively ‘low technology’ concomitant production of biofuels, food or other feedstock chemicals with waste water treatment and remediation by algae would be extremely valuable on a global scale.

In addition to research on the production of algae and the engineering of practical systems, the Institute would also focus on detailed considerations of complex public health, safety, and environmental issues. Public outreach and education efforts will be included to ensure the production of algae based products evolves as economically feasible and acceptable. Thus a part of the mission of the Institute will be to develop cutting edge synthetic biology and biotechnology programs to engineer algae in order to create useful new organisms for the sustainable production of a wide variety of organic chemicals useful to humans for a panoply of products, from food to fuels to medicines, in an environmentally responsible and sustainable system.

**OBJECTIVES:** Specific objectives of the regional Institute are to:

* Identify and develop appropriate algae strains for bioproducts applications.
* Develop and improve technologies for production and processing of algae biomass.
* Evaluate and develop environmentally responsible and sustainable production systems.
* Focus on considerations of complex public health, safety, and environmental issues.

**EXPECTED OUTPUTS, OUTCOMES AND/OR IMPACTS**: Five critical areas of research in the West have been identified: Biofuel development, Bioproduct development, Carbon Sequestration/Management, Bioremediation and Water Management. No one institution has the capacity to address all issues but it is expected that collaborations among the interested Land Grant Institutions (Alaska, Arizona, Hawaii, Nevada, New Mexico, Oregon, Utah, Washington) will be able to better focus possible and ongoing research efforts.

1. **Biofuels:** Many algae exhibit high productivity and high lipid content. Algae can also consist of up to 20-30% carbohydrates, which can be converted into biofuels such as ethanol or butanol, as well as protein, which can be converted for methane production or be used for food or fuel. Significant technological hurdles remain for large scale commercialization or making algae biofuels cost effective.
2. **Bioproducts:** Algae are presently grown around the world for high value products such as pharmaceuticals and nutraceuticals like omega 3 fatty acids (DHA) which are important for brain development in infants. Traditionally fish oil was an important source of DHA. However due to a predicted worldwide shortage of fish oil, it may be prudent to explore algae as a source of DHA, a high value nutraceutical.
3. **Carbon sequestration:** Studies have demonstrated as much as 50-70% of the CO2 produced by a coal-fired power plant can be sequestered by algae growing in open ponds and/or closed photobioreactors, Growing algae using power plant flue gases and waste waters thus achieves the twin goals of providing renewable biofuels and improving water quality. However, more research and pilot scale demonstration plants are needed to encourage investment in this critical area.
4. **Bioremediation:** Worldwide, management of municipal sewage is an issue, especially when discharge of untreated sewage leads to contaminated water sources and eutrophication of water bodies. Growing algae using waste waters achieves the twin objectives of renewable fertilizer production and improved water quality. Additionally, treatment of waste waters contaminated with heavy metals by certain species of algae can represent a low cost alternative to recovery of heavy metals. Further, algae can be grown using agricultural runoff or partially treated municipal waste.
5. **Water management:** Fresh water availability is a critical resource in many parts of the world, including the western U.S. Production of biomass can use substantial amounts of water and significant amounts of fresh water are generally required during conversion of biomass into biofuels such as ethanol. Further, large scale production of biomass may require additional use of fertilizers and pesticides, which could reduce ground or surface water quality and contribute to pollution. Best management practices developed to improve water use efficiency and quality will be critical for sustainable production.

**LIST OF PARTICIPANTS**: Expected members from interested Land Grant Institutions of Alaska, Arizona, Hawaii, Nevada, New Mexico, Oregon, Utah, Washington, and possibly the insular Pacific.