

H₂OPE Biofuels, llc is an early-stage bio-hydrogen company located in Medford, OR. The company is focused on the commercial production of molecular hydrogen from light, water, and photosynthetic algae, using patented intellectual property to modify algal DNA. H₂OPE Biofuels plans to use or license its technology to enter the multi-billion dollar market for hydrogen in the near term, while positioning itself as the technology leader for a future hydrogen-based economy.

Company History: Founded in 2008 in Denver, CO and based on eight years of academic research.
Industry/Sector: Industrial gas, Biofuels, Biotechnology
Target Market: Merchant hydrogen, Chemical manufacturers, Oil and gas producers, Industrial processes.
Competitive Adv: Disruptive new entrant into industrial gas production with decreased capital and operating expenditures
Financial Profile: Received start-up funding of \$210,000 and grants of \$230,000. Seeking \$0.5M to retire remaining technical risk.
Technology Partners: We are looking for grant partners to retire the remaining technological risk. H₂OPE Biofuels has two issued patents covering biological hydrogen production from both algae and bacteria and a well-established commercialization partner.
Contact: Rich Chapas at rich@h2opebiofuels.com or (410) 920-3369.

Project Overview

H₂OPE Biofuels will create emission-free hydrogen production for commercial and industrial users. Our technology allows for commercial-scale production with significant reductions in capital and operating expenditures. Biofuels from algae have not been largely successful in the past, but we use breakthrough genetic-engineering technology to isolate algal hydrogenases with increased production and increased tolerance to oxygen. We will expand on our patented library of hydrogenase mutants and algal research in order to create a diverse library of algal mutants. We plan to provide an opportunity for follow-on financing from major industrial companies in order to construct production facilities to serve merchant or on-site hydrogen customers.

Merchant hydrogen is a \$2 billion to \$5 billion market in the United States and a \$150 billion market worldwide. Hydrogen is used in industrial and chemical operations; the primary production method is steam reformation of coal or natural gas, a highly complex and energy-intensive process that releases large amounts of carbon dioxide. Production is dominated by four companies, creating a virtual monopoly. H₂OPE Biofuels' technology will allow for the creation of hydrogen from water via inherently simple biological processes, creating no emissions, sequestering carbon dioxide, and reducing capital and operating expenditures. Given the current climate on environmental sustainability, H₂OPE Biofuels creates unique opportunities for emitters to reduce their carbon impact.

Problem Addressed: Hydrogen for industrial processes is currently produced by steam reformation of coal and natural gas, a chemical process that requires large amounts of energy and generates sizeable amounts of carbon dioxide emissions. In photosynthetic hydrogen production, a biological process sequesters carbon dioxide and produces only hydrogen, ultimately emitting only water and energy. In order to make algal hydrogen profitable, we must increase the efficiency of the mechanism that causes algae to emit hydrogen during photosynthesis. H₂OPE Biofuels will utilize accomplish this by utilizing the patented technology developed by Dr.

Scott Plummer — a process that exerts evolutionary pressure on algal enzymes to achieve the desired mutations.

Cost Comparison of Hydrogen Production Methods (millions of U.S. dollars)						
Hydrogen Feedstock	Natural Gas (estimate)		Coal (estimate)		Algae (projected)	
Plant Size (million scfd)	5	20	5	20	5	20
Capital Expense	15.0	39.0	45.0	120.0	7.0	19.0
Operating Expense	12.6	50.4	13.0	52.0	0.8	1.8

Recognition of the strength of our technology has been received by the acceptance of journal articles, most recently in Enzyme & Microbial Technology, where we describe how we obtained a nearly 400-fold increase in hydrogen production.

Competitive Advantage

The production of hydrogen through steam reformation involves significant costs in capital expenditures and feedstock. Cost comparisons are as depicted in the table above. Since algae are both cheap and easily producible, H₂OPE Biofuels' technology will allow major cost savings due to the significant reduction in feedstock costs. Research by leading scientists indicates that full success would allow for 5 million standard cubic feet per day of hydrogen to be produced, with a savings of more than \$10 million in annual operating expenses.

Environmental Advantage

H₂OPE Biofuels' technology presents another competitive advantage. Existing hydrogen production plants have been identified as a source of carbon dioxide emissions, and these plants may become subject to federal climate change legislation. Hydrogen is essential to refineries, which use it to remove sulfur from transportation fuels to meet ambient air quality standards. It is possible that limits or offset requirements may be applied to carbon dioxide emissions from these facilities in the near future. Furthermore, H₂OPE Biofuels' technology will allow for current producers to utilize algae as a profitable means of generating hydrogen; because algae naturally sequesters carbon dioxide, companies can reduce emissions or provide offsets to comply with future legislation. In the future, hydrogen will probably have a significant impact on the transportation industry by reducing tailpipe emissions to zero.

Competitive Landscape

The merchant hydrogen market is dominated by four players, one or more of who will become our customers and/or co-development partners. Air Liquide has indicated interest in pursuing licensing negotiations to market our technology to small end-users. H₂OPE Biofuels has patented technology and will further refine and develop new intellectual property to act as a further barrier to entry.

Technology Partners

H₂OPE Biofuels has developed relationships with Air Liquide, Membrane Technology & Research, Merrick & Co., University of Oregon, Southern Oregon University, Ben-Gurion University (Israel), and MPr&D LLC. All developed intellectual property will be the property of H₂OPE Biofuels.

Potential Liquidity

Early market entry into the small-scale market through licensing with Air Liquide, resulting in a deliverable and potential exit point immediately after the elimination of the technical risk; a second exit point exists after establishment in the merchant market to a large industrial gas company in three to five years.

Intellectual Property

H₂OPE Biofuels has two issued patents covering biological hydrogen production from both algae and bacteria, its entire library of mutant hydrogenases, and a predictive computational model that predicts the structures of hydrogenases with improved function.

Taken together, this intellectual property provides a significant barrier to entry into the biohydrogen market.

We continue to build the technological basis for patents and commercialization.

Management Team and Contact Information

Richard Chapas, PhD – rich@h2opebiofuels.com

25 years in commercialization of new technologies resulting in \$30 million in sales. (410) 920-3369

Scott Plummer, PhD – scott@h2opebiofuels.com

10 years' genetic engineering experience: H₂OPE, NSF grants, three patents. (303) 523-1811

F.C. Thomas Alnutt, PhD – NSF program manager (ret.), Algal Biotech Expert, former PhyCal Senior VP

Mark Plummer, PhD – Commercialized seven processes (saving \$500 million), 35 patents.