HEAVY DUTY GREEN SYMPOSIUM TRACK

LOOKING AHEAD: EMERGING & FUTURE ALTERNATIVE FUELS & POWERTRACTS

Moderator: Stephane Babcock, HDT Magazine

Panelists:
Joshua Goldman, Transpower
Elliot Hicks, Oberon Fuels
David Johnson, Achates Power
Dan Phillips, Solazyme
Panelists

Joshua Goldman, Vice President of Business Development, TransPower

Elliot Hicks, Co-Founder and Chief Operating Officer, Oberon Fuels

David Johnson, President and CEO, Achates Power

Dan Phillips, Director, Fuels, Solazyme
TransPower at a Glance

Headquarters: Poway, CA

- 22,000 square foot leased facility
- In business since 2010

33 Employees

- 16 engineers
- 16 technicians
- 1 administrator
- 22 full-time
- 11 part-time or subcontracted

Key Products

- Drive systems, subsystems, and components for heavy-duty electric and hybrid vehicles
- Stationary battery energy storage systems

Financial/Other

- 9th Fastest Growing Company in San Diego County (2011-2013)
- First winner, PortTech LA “Advancing Innovation” award
• Advanced, functional zero-emission system for Class 8 trucks
• Designed to be adaptable to transit buses
### Key Demonstration Projects

<table>
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<tr>
<th>Project</th>
<th>Features</th>
<th>Funding Sources and Partners</th>
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| ![](truck_image)                                                        | • 11 battery-electric and hybrid trucks to be demonstrated at Ports of L.A. and Long Beach  
• First 3 electric trucks have been completed and have exceeded performance and reliability of all prior electric Class 8 trucks | • California Energy Commission  
• U.S. Department of Energy  
• Ports of L.A. & Long Beach  
• South Coast AQMD  
• $5M+ in total grant funding  
• Fleet operators: SA Recycling, Total Transportation Services |
| ![](tractor_image)                                                     | • Latest generation battery-electric tractor recently entered service with IKEA  
• 4 additional tractors to be deployed by the end of 2014  
  - 2 at Port of Los Angeles  
  - 2 at BNSF Railway | • Texas Commission on Environmental Quality  
• California Air Resources Board  
• Various air districts  
• Ports of L.A. & Long Beach  
• $3M+ in total grant funding  
• Fleet operator cost sharing |
| ![](bus_image)                                                          | • First Type D electric school bus completed, approved by CHP, and operated successfully by two school districts in 2014  
• Six Type C electric school buses to be built in 2015 in project involving Clinton Global Initiative | • California Air Resources Board  
• California Energy Commission  
• U.S. Environmental Protection Agency  
• Various air districts  
• Various school districts  
• $2M+ in total grant funding |
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Elliot Hicks
COO, Oberon Fuels
Simple Fuel

Dimethyl ether (DME)

- **Diesel-like Performance**
  - Power and torque of diesel engine
  - High cetane, compression-ignition fuel
  - NO carbon-carbon = NO part. matter = NO DPF

- **Propane-like Handling**
  - Stored in propane cylinders/tank, only change seal
Made from Wasted Resources

Food Waste

Landfill

Flared Gas
Cost-effectively converts methane and CO$_2$ to DME
Skid-mounted Fuel Production

April 15, 2013
Chicago, IL

May 17, 2013
Brawley, CA
DME Simple Engine
Simple Engine

• Diesel engine
  – Desired power and torque of a diesel engine
  – DME compression ignites (cetane 55-60)
  – Runs on 100% DME, not dual fuel system

• Simplified after-treatment systems
  – NO particulate matter generated when DME combusts = NO diesel particulate filter (DPF)
  – Since no particulate matter, easier to control NOx
Simple Infrastructure

• **Storage & Dispensing**
  – Simple, stainless steel propane storage tanks
  – Inexpensive propane dispensing
  – Diesel-like fueling times
  – Tanks & dispensers only require seal changes

• **Safety**
  – Handles like propane
  – Liquid ~ 73 psi (liquid inj. throughout engine)
  – **NO** cryogenics or high compression
DME Status

Fuel-grade DME
- Produced in southern CA
- 1st known commercial DME catalytic distillation column

ASTM Standard Published 2014
ASTM D7901-14a DME as transportation fuel

DME-powered Trucks Demonstrations running in US

RINS EPA Pathway under review

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October 29-30, 2014
Renaissance Schaumburg Convention Center Hotel • Schaumburg, IL

Elliot Hicks
COO
elliot@oberonfuels.com
David M. Johnson
President & CEO
October 2014
Company Overview

- Founded in 2004 by Dr. James Lemke and the late John Walton
- More than $100 million of capital invested
- State-of-the-art facilities and analytical tools
- Demonstrated and customer validated results based more than 6,000 dynamometer test hours
  - Clean: meets the most stringent standards
  - Dramatically more efficient:
    - 20+% versus the most efficient engines (CI)
    - 50+% versus the most common engines (SI)
  - Lower cost, mass and complexity
  - Multi-fuel capable
- Comprehensive, global IP portfolio with more than 2,000 claims in 57 issued and 105 pending patents
Opposed Piston Engine Technology

4.9L 3-Cylinder Engine
- Seven months and 700 hours of testing completed to date
- Validates 10 years and 6,000+ hours of prior development testing.
- Development on-going

• Actual dyno measured performance
  - 15% more efficient than other leading manufacturers’ diesel engines
  - Meets EPA emissions standards

• Measurements validate published performance claims
  - 24% more efficient than production medium duty diesel engines
  - 20% more efficient than production heavy duty diesel engines
  - More efficient than U.S. DOE SuperTruck engine efficiency goals without added cost
  - Cleaner and 30% more efficient than a next generation, advanced, diesel engine and 86% more efficient than a gasoline V8 in a light duty pickup truck
Fuel Efficiency Savings

One Class 8 Truck
- Drives 120,000 miles per year
- Consumes 20,000 gallons of fuel per year
- Cost of ~$80,000 per year on fuel alone

One Commercial Fleet
- 7,200 trucks
- 800,000,000 miles per year
- Annual fuel costs in excess of $500 million

All U.S. Class 8 Trucks
- 2.5 million trucks

HD Trucks World Wide
- 400 billion miles per year

Annual Savings
- $16,000
- $100 million
- $24 billion
- $100+ billion

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Heavy-Duty Fuel Efficiency Advantage

Achieved without SuperTruck technologies, i.e. without waste heat recovery, variable valve actuation, high peak cylinder pressure, and next generation after treatment.
Ask our Advisory Board Members

Dr. David Foster
Phil and Jean Myers Professor Emeritus
Engine Research Center
University of Wisconsin - Madison

David Merrion
Former Executive VP, Engineering
Detroit Diesel Corporation

Wallace Wade
Former Ford Technical Fellow
Ford Motor Company

Dr. Ward Winer
Emeritus Chair
School of Mechanical Engineering
Georgia Tech

Dr. James Lemke
Founder and Chief Scientist
Achates Power, Inc.

Dr. Walter Bryzik
Former Chief Scientist
U.S. Tank Automotive Research, Development and Engineering Center

Daniel Hancock
Former Vice President
Global Powertrain Engineering
General Motors Corporation

Bruno Linsolas
Former Senior VP, Purchasing
Volvo Powertrain

Dr. Karl Viktor Schaller
Former Head of Engineering/Advanced Engineering/Former Board Member
MAN

Dr. S.M. Shahed
Former VP/Corporate Fellow
Advanced Technology
Honeywell Turbo Technologies

6 SAE Fellows
4 ASME Fellows
4 NAE Members

Distinguished Presidential Rank Award, SAE Medal of Honor and SAE Service to Society Winners

Co-authors of Super Truck and National Academy Studies

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For more info:

www.achatespower.com
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Green Fleet Conference

Delivering sustainable, high performance algal derived fuels

Dan Phillips
Director, Fuels Operations
WHY MICROALGAE

Microalgae

A single cell algae 1.5 billion years in existence is the heart of our biotechnology platform solving some of the worlds biggest problems with one of the world’s smallest organisms.
THE THREE SOURCES OF OIL TOUCH OUR LIVES DAILY

- PETROLEUM
  - Jet Fuel
  - Dielectric Fluids
  - Hose
  - Tires
  - Boots
  - Diesel
  - Lubricants
  - Engine Grease
  - Car Seating

- PLANT OILS
  - Medicine
  - Soap
  - Shampoo
  - Lotion
  - Detergent
  - Floor Tiles
  - Shampoo
  - Soap
  - Lotion
  - Detergent
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  - Lotion

- ANIMAL FATS
  - Food
  - Clothing
  - Mattress
  - Computer
  - Paint
  - Ceiling Tiles
  - Upholstery
  - Adhesive
  - TV Frame
  - Lacquer
  - Candles
  - Floor Tiles
  - Shampoo
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BREAKTHROUGH RENEWABLE OILS PLATFORM

FLEXIBLE INPUT
- Sugarcane
- Corn and Stover
- Sugar Beets
- Switchgrass
- Forest Residue
- Waste Streams

HIGH-VALUE MARKETS
- Skin & Personal Care
- Nutritionals
- Chemicals
- Fuels

HIGHLY PRODUCTIVE MICROALGAE
- > 80% oil*
  *The average wild algae only has a 5-10% oil content

- 11+ years of research and development
- $500M+ invested
- 175 scientists and engineers
- Tailored oils in a matter of days

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SUSTAINABILITY PROFILE OF SOLAZYME OILS PRODUCED IN BRAZIL

Low GHG footprint
- Lower GHG profile than most other vegetable and animal oils, and far lower than petroleum

Low land use impact
- Oil yields per hectare equivalent to the average yield of palm oil and exceed nearly all other plant oils
- No significant land use change - sugarcane grown for more than 40 years

Low water consumption
- Lower water consumption most plant-based and animal oils
- Facility is in a low water stress region
FUELS DIVISION - HIGHLIGHTS

Biofuel provider for RIMPAC 2012
US Navy

1st Ever US commercial Flight with Biofuel
United Airlines

Collaboration for TDI® Clean Diesel Technology
Volkswagen
SOLADIESEL™ - SIGNIFICANT CARBON REDUCTION BENEFITS

- **Ultra Low Sulfur Diesel**
- **Compressed Natural Gas**
- **EPA Advanced Biofuel**
- **Soladiesel**

Petroleum Baseline

50% reduction

Exceeds the advanced biofuel requirements

$g\text{CO}_2\text{e} / \text{MJ}$
SOLADIESEL™ - EMISSIONS PROFILE

% REDUCTION COMPARED TO 100% ULSD

- PM$_{2.5}$
- CO$_2$
- CO
- NOx

Data from Khan et al., Energy Fuels 26, 6137-6143 (2012); PM$_{2.5}$ = particulate matter smaller than 2.5 microns;
Reductions are average of 5 engine load levels from 10-100% power (ISO 8178-4 D2 method)

- ISO 8178-4 D2 emissions data collection procedure
- Emissions compared between 100% ULSD and 50/50 blend of Soladiesel$_{SD}$ and F-76
- A 4.5% improvement in fuel economy with was observed

T/S State of Michigan
SOLADIESEL™ - OPERATIONAL BENEFITS

Genentech
A Member of the Roche Group

- Soladiesel in 100 and 20% blends used
- Maintenance benefits, exceptional performance and environmental benefits

6 weeks use of 20% Soladiesel RD (A20) left the fuel filter clean
6 weeks use of 5% biodiesel (B5) left the fuel filter clogged

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GLOBAL MANUFACTURING CAPACITY

- 20K MT oil facility in Clinton, Iowa
  - Operating since January 2014
- +1,800 MT/yr facility in Peoria, IL
  - Utilized for manufacturing-scale sampling
- 100K MT/yr facility in Sao Paolo State, Brazil
  - Completed and in early stages of production
Currently delivering Soladiesel™ blends in the US

Utilized as a drop-in replacement for diesel fuel in on-road fleet use