C2M
Cleantech to Market

UNIQUE INSIGHTS INTO LEADING-EDGE CLEANTECH INNOVATIONS

Brian Steel, Bev Alexander & Bill Shelander (B3)
Who Are We?

• **Brian Steel**
  - PG&E officer
    (Corporate Strategy & Development – renewable energy financing)
  - Three-time CEO + multiple advisory roles
  - Internet technology
    (22 boards, 3 IPOs)
  - Investment banking
  - Duke University

• **Bev Alexander**
  - PG&E officer
    (Utility Clean Energy, Customer Service, & other initiatives)
  - Environmental law & policy
    (National Law Journal “Top 40 Under 40”)
  - Haas Best Case Award
  - Berkeley Law

• **Bill Shelander**
  - Founder & CEO of multiple companies
  - LBL business development
  - Managing Director multiple VC funds
  - Product & line operations
  - White House OSTP
  - MBA/Engineering degrees
What is C2M – The Program?

Cleantech to Market (C2M) is a partnership between students, entrepreneurs, researchers, and professionals to translate low-carbon energy, green chemistry, and water technologies into early-stage market opportunities.

Through its rigorous, interdisciplinary process, C2M helps develop the next generation of innovative cleantech leaders.
...Add 100 Years of “Progress”...
Her Grandchild’s World

2015
What Problems Does C2M Address?

Potential cleantech solutions remain in the lab or incubator because they achieve technical rather than market breakthroughs.

“Valley of Death”
C2M’s Diverse Technology Sourcing

• **C2M accepts cleantech** from top-tier universities, national labs, start-ups, DOE programs (ARPA-E, Cyclotron Road), etc.

• **C2M applies a structured commercialization process** to provide those researchers & entrepreneurs with insights + recommendations
“Steady Stream of Successes”*

- Imprint Energy (2010)
- SiElectra (2010)
- Heliotrope (2011)
- Slice Energy (2012)
- CinderBio (2013)
- Point Source Power (2013)
- ReMaterials (2014)
- South Pole Magnetics (2014)
- Connora Technologies (2015)
- Indoor Reality (2015)
- Spark Thermionics (2015)
- Nelumbo (2016)
- Synvitrobio (2016)

- Market feedback
- Best paths to market
- New ideas on target markets
- Research refinement metrics

*Carol Mimura, Assistant Vice Chancellor
• “C2M provides researchers with insights on the critical questions to address to move projects closer to commercial relevance, and in-depth market analyses that catalyze industry investments.

• Several startup companies have also emerged from C2M activities, so you are an economic driver of the region as well.

• C2M occupies a vital niche in the continuum from basic research to commercial products and services.”
Engaged Sponsors & Partners

“C2M is a key program for Dow at Berkeley, leading the way in identifying key clean technologies and providing smart and useful market analysis”.

Steve Hahn
Research Fellow
Dow Chemical Company
Satisfied Entrepreneurs & Researchers

• "My C2M team was extremely insightful, hard working, and capable - a gigantic value-add, and we're using their findings in grant applications and fundraising pitches.” Zachary Sun, CEO, Synvitrobio

• “We received an SBIR grant thanks in large part to the incredible work done by our C2M team!” Jill Fuss, Co-Founder, Cinder Bio

• "We were thrilled with the progress, understanding, and relationships that developed in the C2M program, and we highly recommend it.” Liam Berryman, CEO, Nelumbo

• "The team did an amazing job of obtaining interviews with key people, which resulted in productive discussions and connections with potential investors.” Steve Yamamoto, CEO, Matrix Sensors

• "I was thrilled to work with a team of students to explore the market opportunities for my research.” Christine Ho, Co-Founder Imprint Energy
Industry Visibility

• **C2M introduces graduate students interested in cleantech/energy careers to relevant companies**
  
  - C2M includes graduate students from 20+ UCB programs

  • **C2M teaches them about technology assessment, market evaluation, presentation, cleantech, interdisciplinary leadership & teamwork + career focusing, guidance, and networking**

• **Coaches/mentors work with C2M students in many ways**
  
  - Speaking to the class
  - Coaching teams and seeing their work “in action”
  - Receiving C2M graduate student resumes of interest
  - Meeting students over lunch (C2M can arrange other meetings, too)
“Best Class I Had at Haas”

• “I strongly encourage any PhD with an interest in pursuing a career outside of academic science to participate in C2M.”
  Alexander Shearer, PhD, Chemistry

• “This class has given me access to clean energy. It helped me make the transitions MBAs are always trying to make.”
  Carlo Woods, Director Financial Planning, SolarCity

• “The class created great contacts that I otherwise would not have met, which was instrumental in leading to my current role.”
  Devesh Khanal, Founder, Devesh Design
...and Jobs! 70% Advanced Energy & Tech
What is C2M – The Course?

- **Fall Semester Course**
  - 40+ graduate students (2/3 Haas 2nd years + 1/3 outside Haas)

- **Annual Four-Phase Program**
  - Project selection (January – March)
  - Team formation (April – May)
  - Program customization (June – July)
  - Technology & market analysis (August – December)

- **Rigorous, Structured Commercialization Support**
  - 48-point, deep market analysis
  - Builds on Haas innovation curriculum
  - Developed & proven over 5 years
Guided Innovation Process

Phase I
Aug 22 – Sept 7

Phase II
Sept 12 – Oct 5

Phase III
Oct 10 – Nov 2

Phase IV
Nov 7 – Dec 8

- Observe & Understand
- Diverge
- Technology to Market Fit
- Converge

- Final Incorp. of Feedback
- Present & Report

Slides & Reports
Start With Great Sources

C2M TOP 50 MARKET RESEARCH WEBSITES

GOVERNMENT – CLEANTECH
California Energy Commission http://www.energy.ca.gov/
California Public Utilities Commission http://www.cpuc.ca.gov/puc/
Clean Energy States Alliance http://www.cleanenergystates.org/
UC DOE http://energy.gov/
  • US DOE Energy Codes http://www.energycodes.gov/
  • US DOE Energy Frontier Research Center http://science.energy.gov/bes/efrc/
US DOE Laboratories http://science.energy.gov/laboratories/
  • Lawrence Berkeley National Laboratory http://www.lbl.gov/
  • LBNL Carbon Cycle 2.0 http://carboncycle2.lbl.gov/
  • National Energy Technology Laboratory http://www.netl.doe.gov/
  • National Renewable Energy Laboratory http://www.nrel.gov/
  • Sandia Laboratory http://www.sandia.gov/
White House Office of Science & Technology Policy
Using (and Writing) Cleantech Cases

Alphabet Energy

Beverly Alexander, Adam Boscoe, Mason Cabot, Philip Dawsey, Luc Emmanuel Barreau, Russell Griffith

Publication Date: Aug 01, 2012
Discipline: Entrepreneurship
Source: UCB - Haas School of Business

Product number: B5717-PDF-ENG
Length: 12p
English PDF

DESCRIPTION
University of California, Berkeley-Haas collection

Alphabet Energy was founded in 2009 with a new thermoelectric technology that had the potential to advance energy efficiency by recovering heat wasted in combustion and mechanical processes. Matt Scullin, Alphabet's founder, and his team were convinced that their product was cheaper to produce, and therefore had more than 80 different potential applications. By 2010, Alphabet was facing its biggest challenge yet--how to select its initial market. After receiving seed funding in early 2010, Alphabet was choosing among four markets: Automotive, Aerospace and Defense, Power Generation, and Manufacturing. Students are provided information to help them make a recommendation.
Conduct Informational Interviews

### Berkeley Energy Network

<table>
<thead>
<tr>
<th>First</th>
<th>Last</th>
<th>Email</th>
<th>Phone</th>
<th>Entity (1)</th>
<th>Sub-Entity (2)</th>
<th>Subject</th>
<th>Sub Subject</th>
<th>Background</th>
<th>Current Organization/Director</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adam</td>
<td>Arkin</td>
<td><a href="mailto:aparkin@lbl.gov">aparkin@lbl.gov</a></td>
<td></td>
<td>Faculty</td>
<td>UCB</td>
<td>Biofuels</td>
<td></td>
<td>His research centers on uncovering the evolutionary design principles of cellular networks and populations and exploiting them for applications. He and colleagues are developing a framework to facilitate applications in health, the environment, and bioenergy by combining comparative functional genomics, quantitative measurement of cellular dynamics, biophysical modeling of cellular networks, and cellular circuit design.</td>
<td>Bioengineering</td>
</tr>
<tr>
<td>Ben</td>
<td>Wu</td>
<td><a href="mailto:bcwu@sandia.gov">bcwu@sandia.gov</a></td>
<td>(925) 294-2015</td>
<td>DOE Lab</td>
<td>Sandia National Lab</td>
<td>Biofuels</td>
<td>Biomass</td>
<td>Biofuel cells, nanophotonic materials, microfluidics, nanofluidics, desalination, biomineralization and enzyme engineering. Most recently, he has been studying enzymes isolated from extremophile organisms that could be applied to the deconstruction of lignocellulosic biomass into biofuel material.</td>
<td>Sandia National Laboratories</td>
</tr>
<tr>
<td>Blake</td>
<td>Simmons</td>
<td>basimmo@sandia</td>
<td></td>
<td>DOE Lab</td>
<td>LBL</td>
<td>Biofuels</td>
<td>Cellulosic</td>
<td>The research program in my lab is largely directed toward understanding how plant cell wall polysaccharides are synthesized, how the structures relate to the functions of the cell wall, and how the system is regulated. I envision that knowledge of cell wall structure and function will facilitate the development of plants with improved utility as sources</td>
<td>Physical Biosciences Division</td>
</tr>
<tr>
<td>Bret</td>
<td>Strogen</td>
<td><a href="mailto:bre@berkeley.edu">bre@berkeley.edu</a></td>
<td></td>
<td>Student</td>
<td>UCB</td>
<td>Biofuels</td>
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3/16/2017
Leverage Haas Core Courses

APPENDIX B - Haas First-Year Core Course Lessons Relevant to Cleantech to Market

**OB&L** = Organizational Behavior & Leadership

**MM&S** = Marketing Management & Strategy

**OM** = Operations Management

**DDS** = Data, Decisions, Statistics

**F** = Finance

**M&ME** = Macro & Micro Economics

**LC** = Leadership Communications

**PFPS** = Problem Finding, Problem Solving
Go Deep on C2M Core’s Analysis

Technology Characteristics & Value Proposition / Customer Segments
- What characteristics define this technology?
- What are the key cost and performance metrics?
- What problems or customer pain does it solve?
- What solutions, benefits or opportunities could it offer?
- What degree of improvement might it offer?
- Are there manufacturing or other issues that might impact the transition from lab scale to commercial scale?
- Is it more likely to become a company, a product, or a feature?
- How will you protect the intellectual property?

Market Selection, Market Sizing
- What is your most promising first market, and who might be your early adopters?
- Are you creating a new market or re-segmentation an existing market?
- How do you define the size and expected growth of your customer segments?
- Who are your buyers, decision makers, users, influencers, recommenders, and saboteurs?
- How will you get, keep and grow your customers?
- How will broader societal, technical, economic, regulatory, and political trends impact you?
- How will global and capital markets, commodities, and existing infrastructure impact you?
Support With Coaching & Teaching

Coach You “In Action”

Learn About the Cleantech Industry
Market Reports

ReMaterials

December 2014
Cleantech to Market
Haas School of Business
University of California - Berkeley

Research Team
Susan Amrose,
Civil & Environmental Engineering, UC Berkeley
Haist Gunstra, Founder, ReMaterials

C2M Student Team
Garith Touchberry, M
Charlotte Rhodes, M
Daniel Wang, MBA 2015
Heather Buckley, PhD
Liz Lowen, MBA 2015
Shula Narang, MBA 2015

Nature’s Building Blocks

Applications for Phage Biofilm Technology

Team Lead:
Jessica Hovick, MBA Candidate

Team Members:
Aaron Beaujette, MBA Candidate
Alexander Shearer, PhD Candidate
Chelsea Gordon, PhD Candidate
Kelly Ling, MBA Candidate
Tom Haywood, MBA Candidate

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University of California, Berkeley

DISTRIBUTED OPTIMAL POWER FLOW ALGORITHM

The smarts you need to manage the smart grid

December 2014
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Haas School of Business
University of California, Berkeley

C2M Student Team
James Alfred, MBA 2015
Ashley Nam Lim, JD 2016
Jonathan Mather, Mechanical Engineering PhD 2017
Ross Trenary, MBA 2015
Bari Wien, MBA 2015
Evan Williams, MBA 2015
Grading – Team & Individual

• **65% Team**
  – Market report – 40%
  – Symposium slides – 25%

• **35% Individual**
  – Peer feedback surveys – 20%
    • 5% mid-semester + 15% end-of-semester
  – Read & comment + instructor observations – 10%
  – Symposium oral delivery – 5%
Team Formation Process

1. Get Info
   - C2M website, faculty, former students

2. Bid / Apply
   - **Team leads (Haas):** Apply! – **March 31 deadline**, interviews **April 4/5**
     * TLs are guaranteed enrollment & Haas allocates 3/13 (230) of their bid points
     * TLs also receive 1 unit of extra credit via an independent study course
   - **Team members (Haas):** Bid! – **Week of April 13**
   - **Team members (outside Haas):** Apply! – **April 28** deadline (“green button” takes you to an on-line application from the C2M website)

3. Rank Top 5 Preferences (stack-rack + 100-pt allocation)
   - We consider your top 5 preferences & CVs in forming teams

4. Get Drafted
   - Team leads “draft” team members on **May 2** (with our oversight)
   - Teams start meeting / communicating before summer

* Haas provides 1,000 points for 13 units; C2M = 3 units; 3/13 of 1,000 = 230
Entrepreneurs & Researchers - Apply Now for Admission to C2M's 2017 Cohort:

- Applications are due by 6 pm on February 28 - for more details and the application form, see C2M's FAQ page.

Dynamic Partnership

Cleantech to Market (C2M) is a partnership between graduate students, entrepreneurs, researchers, and industry professionals to help accelerate the commercialization of emerging cleantech. In the process, C2M also develops the next generation of innovative cleantech leaders.

- Entrepreneurs & Researchers
  C2M first evaluates and selects promising cleantech inventions from existing startups, leading universities, and Department of Energy labs.

- Graduate Students
  C2M then handpicks graduate student commercialization teams from over 20 UC Berkeley disciplines, including business, engineering, science, law, policy, and the Energy and Resources Group. C2M matches their academic and work experience with each project.

- Cleantech Professionals
  C2M supports the teams with leading cleantech professionals who bring deep subject matter expertise in e.g., batteries and related components and controls.
Strength from Diversity & Depth

• Haas Students
  – Accounting/Finance
  – Architecture
  – Business Development
  – Communications
  – Consulting
  – Economics
  – History
  – Information Systems
  – Marketing & Sales
  – Mathematics
  – Operations
  – Political Science
  – Project Management

• Non-Haas Students
  – Biology
  – Chemistry
  – Computer Science
  – Energy & Resources
  – Environmental Science
  – Engineering
    • Chemical
    • Civil
    • Electrical
    • Environmental
    • Industrial & Operations
    • Mechanical
    • Nuclear
  – Law
  – Materials Science
  – Physics
  – Public Policy
2017 PROJECTS
Hot Off the Press – 2017 Finalists!

- Sunvapor
- Roshan Energy (SunSmart Skylights)
- Ultrathin
- Packetized Energy Management
- Grow Plastics
- eCalCharge
- Dragon Slayer
- Micro OrganiTech
- GreenBlu
- SHYFT (Solstice)
“Industrial Solar Steam”

Market Need

Process heat accounts for 70% of industrial energy use. Food processing alone in California consumes 11 TWh, equivalent to burning 300 million gallons of gasoline every year. Today’s price of natural gas paid by large PG&E commercial customers is $9/MMBtu. There is a need to reduce CO2 and NOx emissions in the food processing industry - which uses steam heat - without inflicting financial pain on the steam consumers.

Technology Solution

Solar thermal is the most efficient technology for generating steam. We received a $2.2 million DOE SunShot Award for a bold concept we patented that cuts the material cost of concentrating collectors in half, enabling steam sales at $6/MMBtu in the Central Valley. We found a way to achieve durable high performance in spite of the highly uncertain properties of the low-cost sustainable material.

Time to Market

We built a lab-scale prototype (lower picture) and validated our performance and cost models. In May, 2017 we will start building the full-scale collector and test it outside at a customer site (see upper picture), Horizon Nut in Firebaugh, California, the heart of the Central Valley. Horizon Nut uses steam for pasteurization. The technology will be ready for commercialization in late 2018 once we are able to give a 10-year warranty, and receive an SRCC-600 certification.

Customer Feedback

Sunvapor exhibited at the California League of Food Processors Expo last year. Customers reacted positively to our proposal of selling clean solar steam instead of requiring a capital investment. Amy’s Kitchen, a market leader in organic foods, told us it would be a “no-brainer” to pay less for solar steam than gas. An almond processor in Madera is building a new facility and would like to use our solar boiler during the daytime once it is commercialized. Nearby, Horizon Nut, one of the largest pistachio processors, will host our SunShot demonstration.

C2M Objectives

- Critique our business hypothesis
- Find creative solutions to our financial challenges
- Help create a compelling case for investment
Roshan Energy: Skylights for a warming planet

- Quarter of all Electricity Use ➔ Lighting
- Current skylights admit too much heat ➔ high AC costs
- Roshan Energy’s proprietary technology enables
  More Light Less Heat
  - Expanding $7B/yr market with lower installed costs
  - Enabling the zero-net energy future for all buildings

C2M can help business dev finance & team (currently 2 Cal alums)
**Background**

Metals have severe limitations due to difficult nanofabrication and chemical, thermal, and mechanical instabilities.

**Feasibility**

We are developing a novel atomic layer deposition (ALD) based technique that enables top quality synthetic metal films.

We have demonstrated these ultrathin (<10-20 nm) and conformal films as high surface area electrodes for supercapacitors and water desalination...

**Question**

What are existing and potential future markets for ultrathin, conformal synthetic metals as high surface area electrodes or stable electrodes for electrochemical devices?
Packetized Energy Management (PEM) creates virtual batteries out of distributed energy resources (DERs) to mitigate the variability inherent in renewable energy.

PEM is inspired by methods for sending data over the Internet, dividing electricity use into “packets.” PEM enables locally-driven, autonomous, private, and fair access to energy, managed in real-time so that demand matches supply.

- Team has decades of experience in power, control, optimization, communication, IoT systems
- PEM is a patent-pending technology resulting from a decades worth of research at the Univ. of Vermont
- Commercialization effort leverages a $1.7M grant to continue advancing PEM-based approaches
- Our startup, Packetized Energy, founded in May '16, is developing solutions for DERs such as electric vehicle chargers & water heaters (product seen in 3rd image)

- Water heater control product is expected to provide up to $250 value/year, with similar potential for other devices
- Participating in C2M will provide our team a clearer understanding of barriers to entry for PEM and competing DER management technologies. In addition, a clearer picture of customer needs and usability requirements will be obtained.
Material Expansion technology enables the replacement of petroleum-based plastic with $\frac{1}{2}$ to $\frac{1}{3}$ the biopolymer by weight!

Goals:
- Billions of Pounds Less Plastic Waste
- Eliminate Carcinogenic and Estrogenic Chemicals from Food Packaging!

Value Proposition

Insulating and Strong!

Our cup (left) uses half the material of traditional cups (right), makes them up to 30% cheaper!

Better for the environment by being 100% plant-based, compostable, and 90% less energy used in production than competitors!

Status and Needs

Funded by NSF and EPA, pilot line being brought up to speed with USDA

Currently 1 Full time engineer, 1 technician, 2 part time investors for sales and CFO. Need help with Biz Dev, Marketing, and Fundraising!
We develop Electric Vehicle smart charging software for fleets of electric cars.

We sell our software to automakers, and coordinate the charging of cars to sell demand-side regulation services to utilities. Currently incorporated, and in a pilot project with a major automaker.

Cleantech To Market partnership
1) Understand the EV charging ecosystem and potential business models.
2) Where does EV smart charging bring the highest value: utilities, automakers, EV fleets, charging networks or drivers?
3) What is the best strategy to enter the market / grow in this ecosystem?
DragonSlayer
Advanced Battery Management System

Fast charge batteries in minutes!

- Safety enforcement technology
- Long Lifespan
- Software-based
Key Market Challenges for MICROrganic Technologies

We are a highly disruptive platform technology that can solve problems in at least six vertical markets. (municipal & Industrial WWT, Frack Remediation, Energy-positive Desalination, Home Septic systems, & emerging economy basic sanitation and energy generation).

Most of these infrastructure techs haven’t changed substantially in generations. (Except DeSal)

Current Access & Products are driven by large corporate players with entrenched interests

The very large Municipal and Industrial WWT markets in aggregate have significant market pain (due to energy costs), but customer “pain” is less urgent, slowing openness to change.

Each market relies on an extensive web of engineering firms, OEMs, regulatory bodies, and other suppliers. Strategic partnerships are critical for new entrants to these markets.

All of these markets are potentially quite lucrative and socially impactful. The challenge is identifying and prioritizing markets and strategic partners.
GreenBlu’s zero-carbon, zero-discharge, low-cost VADER technology solves desalination. Who will buy first?

Pending Patents: Adsorbent, VADER, Solar Collection

Containerized distiller & crystallizer produces magnesium (MgCl), and salt (NaCl)

Customers:
- Industry
- Public and private water systems
- Military
- Disaster relief
- NGO

Reasons to buy:
- Lower water cost
- Near zero OpEx
- Sustainable
- Reduced testing
- Valuable Solids
- Accepts all input

© 2017 GreenBlu | www.GreenBlu.co | howardyuh@greenblu.co
Winner of Cleantech Open Northeast Region 2016 & Cleantech Open National Water Impact Honor 2017
**Introduction**

For millions of people around the world who struggle to manage back-up power supply, Solstice sells the SHYFT, a hybrid smart meter & transfer switch that enables the next generation of distributed energy management.

**Technology**

SHYFT combines the functionality of a transfer switch and a smart energy meter to create a new category of internet-of-things products that solve energy challenges in the developing world. By integrating a revenue grade meter and high capacity switching components, we can monitor and manage a home’s power supply in real-time and provide access to these features directly to the user through a mobile application. Our backend software analyzes the data collected to recommend interventions for energy efficiency, as well as size and design clean and affordable alternatives for back-up power supply.

**Customers**

While our market will extend across Africa and other developing countries, our initial market is in Nigeria, where 60M homes and business rely on back-up generators. We sell our technology to homes, property managers, and real estate developers, who each benefit from our product.

**Data as a Key Asset**

Our vision is based around actionable data. The dataset we develop will be first comprehensive insight into energy usage in Nigeria. We are interested in developing and pursuing opportunities to maximize the impact this data can have on clean energy integration and management.

**Progress**

We have completed software development of our MVP platform and will be testing the fully-rated SHYFT prototype in the next month. We’ve collected 18 pre-orders for our first batch of hardware units.
THANK YOU