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

• **Beverly 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

• **To Be Announced**
  - Adding a third C2M instructor in 2016
  - Enhancing coaching availability
  - Additional experience in cleantech commercialization and technology transfer
What is C2M?

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

Through its rigorous, interdisciplinary process, C2M helps develop the next generation of innovative cleantech leaders.
My Grandmothers’ Childhood Home

1915
...Add 100 Years of “Progress”...
Their Great-grandsons’ 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)
- Jaintawn (2011)
- Slice Energy (2012)
- CinderBio (2013)
- Point Source Power (2013)
- EAN (2014)
- ReMaterials (2014)
- South Pole Magnetics (2014)
- Connora Technologies (2015)
- Indoor Reality (2015)
- Spark Thermionics (2015)

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

*Carol Mimura, Assistant Vice Chancellor
Vital Niche in Innovation Ecosystem

• “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.”

Carol Mimura
Assistant Vice Chancellor
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 Researchers & Entrepreneurs

• 100% of the researchers and entrepreneurs responding to a recent survey felt that the C2M program was “valuable” or “extremely valuable” with respect to providing:
  – Market information that they hadn't had the time or resources to discover, especially regarding price points, competitors, customers, manufacturing issues, and barriers to entry;
  – Niche markets that might serve as “stepping stones” towards their ultimate market; and
  – Articulation of key next steps.
Satisfied Researchers & Entrepreneurs

• “The C2M team was dedicated, professional, and incredibly deep and thorough. They provided possible technology solutions and avenues I hadn't considered or had brought to my attention, despite thinking about my field for more than 5 years. I was quite impressed.”
  – 2015 cohort scientist

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

• “On every criteria – rigor, relevance, realism, grasp of the technical, policy and business implications, this was nowhere near good, it was great.”
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
## Sample C2M Alumni

<table>
<thead>
<tr>
<th>Role</th>
<th>Company/Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Founder &amp; CEO, Building Robotics</td>
<td>Energy Finance, Google Access &amp; Energy</td>
</tr>
<tr>
<td>Business &amp; Project Development, Makani</td>
<td>Senior Program Manager, EcoFactor</td>
</tr>
<tr>
<td>Senior Policy Analyst, Future Energy Enterprises</td>
<td>Environmental Finance, Wells Fargo</td>
</tr>
<tr>
<td>Energy Partners Product Strategy, Nest Labs</td>
<td>Marketing Business Manager, Sungevity</td>
</tr>
<tr>
<td>Electric Vehicle Program Manager, PG&amp;E</td>
<td>CoFounder &amp; Chief Battery Engineer, Blue Current</td>
</tr>
<tr>
<td>CEO, Persistent Efficiency</td>
<td>Program Manager, Berkeley Energy &amp; Climate Institute</td>
</tr>
<tr>
<td>Renewable Energy Professional, SunEdison</td>
<td>Senior Manager, Bloom Energy</td>
</tr>
<tr>
<td>Emerging Grid Technologies &amp; Principal, PG&amp;E</td>
<td>CEO EcoMachines Ventures</td>
</tr>
<tr>
<td>Director, Grid Economics &amp; Markets, SolarCity</td>
<td>Senior Engineering Project Manager, C3 Energy</td>
</tr>
<tr>
<td>Client Solutions Executive, Opower</td>
<td>Investor, Illuminate Ventures</td>
</tr>
<tr>
<td>Product Marketing Manager, EnPhase Energy</td>
<td>Mechanical Engineer, LightSail Energy</td>
</tr>
<tr>
<td>Finance, Renewable Energy Trust Capital</td>
<td>Director Materials Integration, Alphabet Energy</td>
</tr>
</tbody>
</table>
What is C2M?

• **Fall Semester Course**
  – 40+ graduate students (2/3 Haas 2\textsuperscript{nd} 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 23 – Sept 8

Phase II
Sept 13 – Oct 6

Phase III
Oct 11 – Nov 3

Phase IV
Nov 8 – Dec 9

Observe & Understand

Diverge

Technology to Market Fit

Converge

Final Incorp. of Feedback

Present & Report

Slides & Reports

Guided InnovaPon Process
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

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

<table>
<thead>
<tr>
<th>First</th>
<th>Last</th>
<th>Email</th>
<th>Phone</th>
<th>Entity</th>
<th>Sub-Entity</th>
<th>Subject</th>
<th>Sub Subject</th>
<th>Background</th>
<th>Current Organization/Division</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adam</td>
<td>Arkin</td>
<td><a href="mailto:aparkin@lbl.gov">aparkin@lbl.gov</a></td>
<td>X</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>Sandia National Lab</td>
<td>Biofuels</td>
<td>Biomass</td>
<td></td>
<td>Biofuel cells, nanophotonic materials, microfluidics, nanofluidics, desalination, biomining unitization 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><a href="mailto:besimmo@sandia.gov">besimmo@sandia.gov</a></td>
<td>DOE Lab</td>
<td>LBL</td>
<td>Biofuels</td>
<td>Cellulosic</td>
<td></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:bret@berkeley.edu">bret@berkeley.edu</a></td>
<td>Student</td>
<td>UCB</td>
<td>Biofuels</td>
<td></td>
<td></td>
<td></td>
<td>UCB</td>
</tr>
</tbody>
</table>

3/9/16
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

Matt Scullin
Founder & CEO
Alphabet Energy
Market Reports

ReMaterials

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

Research Team
Susan Arnow, Civil & Environmental Engineering, UC Berkeley, Haas Grad Assist, Founder, ReMaterials

C2M:
Collin
Charlie
Daniel
Lisa
Signe

DISTRIBUTED OPTIMAL POWER FLOW ALGORITHM
The smarts you need to manage the smart grid

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

C2M Student Team
James Allred, MBA 2015
Ashley Nan Lin, JD 2015
Jonathan Mathers, Mechanical Engineering PhD 2017
Kris Trenary, MBA 2015
Eari Won, MBA 2015
Evan Williams, MBA 2015

Nature’s Building Blocks
Applications for Phage Biofilm Technology

Team Lead:
Jessica Hoick, MBA Candidate

Principle Investigator:
Professor Seung-Wuk Lee

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

December 2014
Grading (2015)

• 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 (now); team leads (after April 5)

2. Bid / Apply
   – Team leads (Haas): Apply! – April 2 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 11
   – Team members (outside Haas): Apply! – April 30 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 3 (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
Lots of Information is Available Online

Energy Institute at Haas

Cleantech to Market

Dynamic Partnership

Cleantech to Market (C2M) is a partnership between students, scientists, engineers, and professionals to translate cleantech research, green chemistry, and water research into market opportunities. In the process, C2M helps develop the next generation of innovative cleantech leaders.

- Researchers and Entrepreneurs
  C2M first evaluates and selects promising cleantech inventions from UC Berkeley and other leading universities, Lawrence Berkeley National Laboratory and other Department of Energy labs, and existing start-ups.

- Graduate Students
  C2M then hand selects commercialization teams comprising top UC Berkeley graduate students from over 20 programs, 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 industry professionals who bring deep subject matter expertise (e.g., electric grid operations, storage, economics, early stage venture). They help guide the students as speakers, mentors, and contacts.
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
2016 PROJECTS
GreenFire (LBL, EPRI)

ECO2G™ Revolutionizes Geothermal with a Closed Loop and sCO₂

ECO2G™

Accesses High Temperatures that Hydrothermal Cannot

Hydrothermal requires fractures for water circulation

ECO2G does not require water and can use high temperatures in the plastic zone
Feasible (Princeton, ARPA-e, Cyclotron Rd)

• A new way to measure the quality & health of batteries using ultrasound.

• Hardware battery manufacturers can use for:
  – Improve how batteries are made and developed
  – Optimize performance to increase total energy output and lifetime
  – Provide sufficient lead time to prevent catastrophic failures from ever occurring
  – Reduce testing time for battery recycling/redeployment

• **Goal:** Improve the way batteries are made, tested, and managed . . . everywhere!
Nelumbo (UCB, BECI, CUP)

OMNIPHOBETM heat exchanger coating

A water- and oil-repellent coating for application to air conditioning cooling coil fins.

- Increased energy efficiency
- Increased air quality
- Increased fin durability
- Streamlined dip-coat application

 Berkeley CUP winner - $100K prize
Opus 12 (Stanford, Cyclotron Road)

Technology vision: Opus 12’s technology would enable an artificial carbon cycle that sequesters carbon dioxide in the form of commodity chemicals or creates carbon-neutral fuels, leading to an overall decrease in greenhouse gas emissions.

Recycling Carbon Dioxide into Chemicals and Fuels using an Electrochemical Process
CalWave (UCB, Cyclotron Road)

**Phase**
- Tank Testing and Simulation

**Date**
- Q2/16

**Milestone**
- Demonstration Prototype
  - 1:50 scale
  - $50k

**Power Rating**
- 1:20 scale and ~ 80 kW

**Capital**
- $450k

**Images**
- Navy Test Tank
- Open sea trial
- Permitted Test Site
- 1/50 Scale Test in Jan/16
Sepion (Cyclotron Road, SBIR, I-Corps)

- Rechargeable lithium-sulfur batteries with special membranes
  - New materials for next generation batteries
  - Lighter weight, lower cost
  - Potential applications include electrification of flight

![Diagram of battery chemistry](image.png)
Matrix Sensors (UCB, UCLA, Stanford, LBL)

- **Two initial sensor targets:** Methane & carbon dioxide.
- **10x lower cost, size & power** with improved performance in specific categories including molecular selectivity, instant on, and 3x faster response time.
- **Platform technology** that could enable other gas sensors.
Synvitrobio (UCLA, Caltech, Cyclotron Road)

- Addresses $50B market for bio-catalyzed processes
- Produces 1000x more data

Synvitrobio develops cell-free systems as a prototyping environment.

1. Faster: 8 hours vs. days/weeks
2. Cheaper: $10 vs. $100/$1000
3. More scalable: 384+ at once
THANK YOU