Clean Energy Venture Capital Investing in Massachusetts
• Fund Overview

• General Clean Energy Industry Overview

• Clean Energy Investing in MA

• Portfolio Companies
Massachusetts Green Energy Fund: Overview

• **$17mm VC fund investing in early-stage clean energy companies**
  – State, accredited individual investors, foundations as LPs
  – 3 General Partners

• **Fund focus**
  – Venture IRRs
  – Early-stage clean and renewable energy opportunities
  – Companies based in or doing business in MA

• **Objective**
  – Portfolio of 10-12 companies
  – Early stage investments & build syndicates
  – 4-6 year exit
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Clean Energy Market Drivers

**Increasing Problems**

- Global energy demand
- Energy price volatility
- Environmental degradation

**Increasing Solutions**

- Clean energy tech innovation
- Government policy
  - Global warming & national security
  - Long term incentives
- Capital availability
Figure 1. U.S. Energy Flow Trends – 2002
Net Primary Resource Consumption ≈ 97 Quads

Source: Production and end-use data from Energy Information Administration, Annual Energy Review 2002.
*Net fossil-fuel electrical imports.
**Biomass/other includes wood, waste, alcohol, geothermal, solar, and wind.
Projected World Primary Energy Demand

- **Oil**: Mostly transportation
- **Coal**: (Electricity) (Heating and electricity)
- **Natural Gas**: (Transportation and electricity) (Electricity)
- **Renewables**:
- **Nuclear**:

Source: EIA 2006
Annual Electricity World Demand is Projected to Double by 2030

Source: EIA 2006
Annual Global CO2 Emissions Are Projected to Rise Significantly

Source: EIA 2006
World Energy Prices Are High and Getting More Volatile

NYMEX Crude Oil Futures Close (Front Month)

2002 avg price = $25/barrel
2002-today multiple = 3.3x

NYMEX Natural Gas Futures Close (Front Month)

2002 avg price = $3/MMBTU
2002-today multiple = 2.3x
Figure 1. U.S. Energy Flow Trends – 2002
Net Primary Resource Consumption ~97 Quads

Source: Production and end-use data from Energy Information Administration, Annual Energy Review 2002.
*Net fossil-fuel electrical imports.
**Biomass/other includes wood, waste, alcohol, geothermal, solar, and wind.
“Cleantech” includes a broad range of technologies

Solar  Hydrogen Generation  Waste Conversion
Wind  Energy Storage  Power Control
Fuel Cells  Biodiesel  Batteries
Hydro  Biomass  Engine Design
Wave & Tidal  Ethanol  Intelligent Grid Software
Efficient Lighting  Efficient Vehicles  Process Efficiency

and many more...
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The Northeast and California have led cleantech investment activity

Annual Dollar Volume of Cleantech Investments, 2005-2006

- Western Canada, $250,275,391
- Eastern Canada, $278,789,351
- Midwest, $497,328,382
- Northeast, $959,643,877
- North Coast, $1,687,311,900
- Rockies/Plains, $75,564,339
- Southeast, $283,617,920
- Southwest, $373,271,643
- Northwest, $128,810,000

- For all of 2005 + 2006 investments, the Northeast ranked second in total dollars invested

Source: Cleantech Venture Network
California is becoming the dominant cleantech market

- The Northeast ranked first or second in number of cleantech investments 7 of the 8 quarters across 2005 & 2006
- Boom in solar investments in the Southwest in 2007

Source: Cleantech Venture Network
California is becoming the dominant cleantech market

- The Northeast ranked first or second in dollars invested 6 of the 8 quarters across 2005 & 2006
- Large-scale solar investments in the SW have recently pushed the Northeast to 3rd place

Source: Cleantech Venture Network
Summary:

• Cleantech continues to be one of the top categories for VC investment

• Energy deals dominate the cleantech category

• Photovoltaics and biofuels represent two of the biggest sectors for energy investments

• The Northeast (primarily MA) led cleantech activity in 2005 and 2006, but has recently fallen behind other geographies
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The Fund has 6 portfolio companies

Characteristics:

**Seed stage**
- Proof of concept, but no prototype
- Incomplete team
- Key customers not yet signed up

**Early stage**
- Prototype, early product, but no steady product sales
- Product longevity testing & durability required
- Key customers evaluating / testing product

**Expansion stage**
- Early product sales; requires investment to achieve greater scale
- Complete mgmt team
- Established customer demand for product
Top technical team – 2 Nobel Laureates

Low cost flexible PV power < $1/W

High speed, low cost reel/reel manufacturing

Prototypes being tested by military and commercial customers
- Fuel cell stacks and systems for the sub-500W portable power market
- 3-5x stack cost advantage
- Portable power system prototypes in tests by military
- June 2006 IPO on London Stock Exchange
MEMS semiconductor-based solid oxide fuel cells fueled by liquid fuel for long-duration portable consumer electronics

- Significant performance advantage over Li-Ion batteries
- First markets: smartphone chargers and industrial PDA battery replacement
- Integrated photovoltaic technology for remote power applications
- Primary markets are municipal, park, and recreational areas
Inexpensive, efficient technology to extract hydrogen from hydrocarbon fuels (gasoline, propane, diesel, etc.)

Significantly lower cost for portable and distributed hydrogen generation

Primary markets are portable generation and uninterruptible power supply (UPS) applications

Patented conducting membrane

Diagram showing the process of hydrogen extraction from hydrocarbons.
Key technology: proprietary high-performance porous membrane for separation applications which other membranes cannot address

Novel membrane technology used to significantly reduce cost of producing bioethanol, biobutanol

Platform technology applies to natural gas processing, too