

- NOTES

- Slide 3. , Terrafore developed two innovative technologies that can reduce the cost of storing energy 1. Actively manage thermocline to enable a maintenance-free (dual media) thermocline storage 2. Store high temperature energy as phase change of inorganic salts (PCM) in small capsules (temperatures to 800 degrees C).

This short presentation focuses on PCM storage technology - challenges we overcame, the benefits and status of technology

- Slide 4. Two main challenges with PCM storage: 1. Salts have low thermal conductivity which means the coefficient to transfer heat will be low and hence to maintain heat rates at rated power large heat transfer area is required. Small capsules (~15mm diameter) have very high specific surface area.

This leads to the second challenge - 2. Salts expand on melting – so if we encapsulate the salt, we should have an open space inside the capsule or some means for salt to expand freely.

Terrafore successfully developed a cost-effective manufacturing process to make capsules with open space. The method called the sacrificial method, is described in a video available on the website. The process is proven and ready-to-scale.

- Slide 5. Distributed solar thermal power generators such as Dish Concentrators and small scale solar power towers from 247 Solar Inc., can benefit from using high energy density phase change storage. Phase change storage using capsules can store energy in small containers which can be installed as counterweight to the Stirling engine which is at the focal point of the Dish. For small towers, the high energy density PCM storage can be factory installed with the Brayton Cycle engine reducing duct work and capital cost.

For large utility scale power tower or parabolic collector systems, a cascaded PCM storage using multiple salts (described in a video on the website) can effectively store energy collected in molten salt in a single tank.

Capsules using very high melting salts such as eutectics of KCl-NaCl or NaCl have been made. This will enable very high temperature (>650C) and hence high efficiency CSP systems.

- Notes: (continued)

- Slide 6. . Terrafore's innovative technology developed using US Department of Energy funds, has been proven in the laboratory and is ready-to-scale.

Currently, Argonne National Labs is testing these capsules for robustness and heat transfer in their test rig using 900C air.

The manufacturing process to make capsules uses equipment that is state-of-the-art in the industry and is commonly used to make capsules for pharmaceutical industry.

- Slide 7. TerraCaps, the product name for encapsulated capsules, have shown to be 6 to 10 times cheaper than battery for storing energy. Long duration storage systems using high temperature capsules can cost effectively store grid electricity or renewable electricity from PV or wind, and generate power as required to make these systems dispatchable.

Terrafore is open to working with customers in CSP industry or process industry to customize a solution for their application

Slide 8. Industry and academia Partners

Slide 9.

Slide 10. Back up slides

Slide 11. Management Team

Slide 12. Click for Video or go to website www.terraforetechnologies.com

Slide 13.

Terrafore Technologies, LLC

Providing Innovative
**Thermal Energy Storage
Technology & Products**
for
Concentrating Solar Power Generation (CSP)
&
Process Industries

ata insights Webinar
June 27, 2018

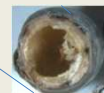
Anoop Mathur

Our Phase Change Technology

Problem: Salts Can Expand ~25% On Melting
Low Thermal Conductivity of Salts

Challenge: Create Open-Space to Accommodate Expansion
Inside Small Capsules

- Successfully Invented A Process ; Three Patents (1 Issued, 2 pending)
- Works for Low & High Temperature Salts
- Manufacturing Process Proven in Lab
Ready-to-Scale



TerraCaps™ Value Proposition

- Distributed Solar Thermal Plants (< 5MW)
 - Only Available Solution
- Utility-Scale Solar Thermal Plants (100MW+)
 - Enables CSP with High Temperature (> 650C / High Efficiency); TerraCaps can be used with salts MPt ~800C

Thereby making it Price-Competitive with Conventional Power



Terrafore Confidential

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Technology Status - Ready to Scale

- Lab Capsules with Various Salts
 - \$2.5MM Technology Development Funds from DOE
 - Completed Life Cycle Tests
 - Collaboration with Leading Institutions
- Third Party Testing of Capsules
 - DOE funds \$170K to Argonne National Labs and National Renewable Energy Labs
- Perfected Capsule Manufacturing Process in Lab



UC RIVERSIDE



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Summary

- **TerraCaps™:**
 - 6X to 10X Cheaper than Battery
 - Only Solution for Distributed CSP
 - Enables Solar Thermal to be Price-Competitive with Conventional Power
- **Ready to Scale-up and Market**
- Energy Storage is Critical for Solar Power;
Massive Market & Growth Potential
- MOU's w/- Potential Customers
- Competent and Experienced Technology & Management Team
- Strong Partnerships with Leading Institutions

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Academic & Industry Partners

terrafore

Dec-30,
2009

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Lead
With
Innovation



terrafore

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Backup Slides

Executive Management Team

Anoop Mathur



- Founder, CTO, Inventor
- >35 years industrial experience
- H.W. Sweatt Award, Honeywell's Prestigious Award for Technology & Business Excellence
- Over 25 Patents
- MS Chem. E., MBA, Carlson School

Kamala Puram



- COO
- Sr. Exec at Fortune 500 companies
- Co-founded Start-up iXmatch Inc
- Women in Technology Award
- MBA, Carlson School

Mahesh Kanumury

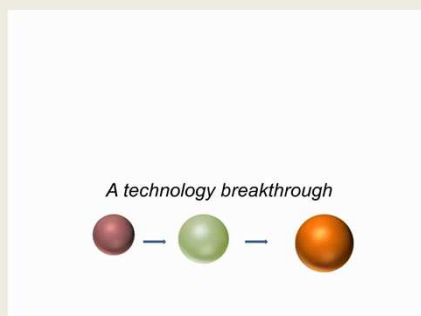


- Board Member
- >25 years in Venture Capital, Management & Consulting
- General Partner, Silicon Valley Venture Fund
- Fortune 500 CXOs at McKinsey
- MD Arivali Partners
- MBA, Harvard

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Click on Videos
Available on website

www.terraforetechnologies.com



1. Encapsulated Storage for CSP (full video)
2. How Capsules are made

Competitive Analysis

TerraCaps Meets All The Key Attributes

Attributes	Terrafore's PCM TES	Two-Tank Sensible Heat TES	Ceramic Solid TES	Foam PCM TES
Low System Cost	Green	Red	Green	Yellow
High Dispatchability	Green	Green	Red	Green
High Temperature	Green	Red	Green	Green
Low Carbon Footprint	Green	Yellow	Red	Yellow
Compact Size	Green	Red	Red	Green

PCM = Phase Change Material
TES=Thermal Energy Storage

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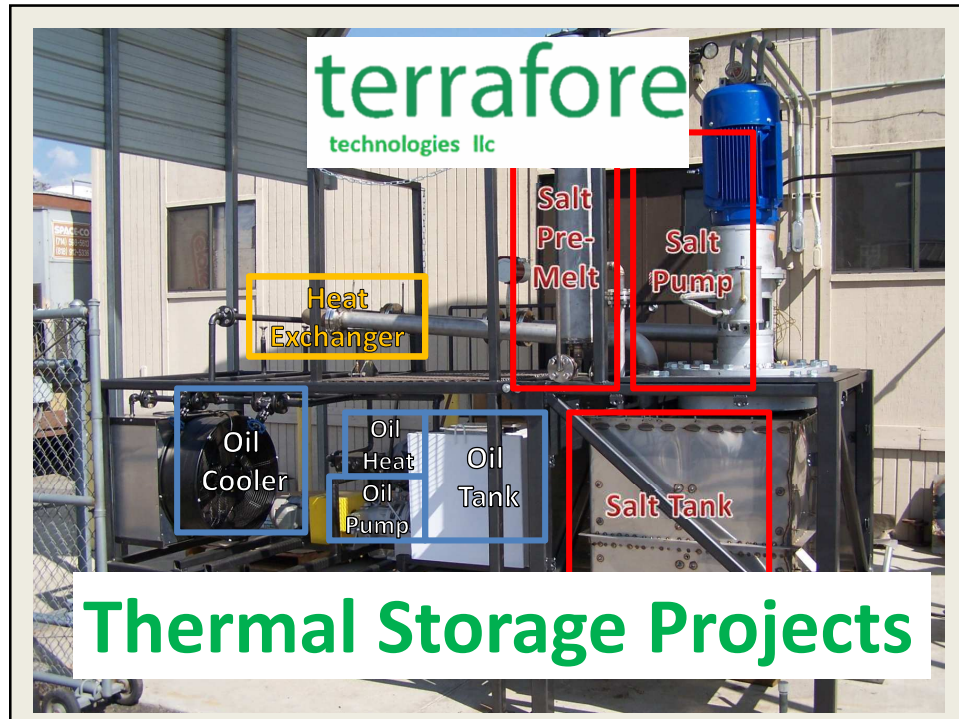
TerraCaps: Lowest Life Cycle Energy Cost

	ELECTRIC BATTERY STORAGE FOR PHOTOVOLTAICS		DISTRIBUTED CSP		CENTRALIZED CSP	
	State Of Art Battery	Near Term Battery	State of Art TES	TerraCaps TES	State of Art TES	TerraCaps TES
30 yr Life Cycle Costs [\$/kWh(e)]	\$ 1,150	\$ 650	No Effective Solution	\$ 100	\$ 150	\$ 60

TES=Thermal Energy Storage

6X to 10X Cheaper Than Battery
Only Effective Solution for Distributed CSP

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Terrafore Thermal Energy Storage Projects

terrafore

- Encapsulated Phase Change Thermal Energy Storage, US Department of Energy (Terrafore Patent)
- Active Thermocline Thermal Energy Storage (Terrafore Patent)
- Value of TES to California grid (California Energy Commission)
- Consulted on Design of Molten Salt Thermal Energy Storage at Tonopah (IDOM, Solar Reserve)