
2008 Solar Annual Review Meeting

Session: Thermal Storage - Overview

Company or Organization: NREL & SNL

Funding Opportunity: Concentrating Solar Program

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Relationship to Solar Program Goals

Storage Overview

“...to make CSP cost competitive in the intermediate power markets by 2015 (~7¢/kWh with 6 hours of storage) and in baseload power markets (~5¢/kWh with 16 hours of storage) by 2020.”

1. Project Overview

a) Description

- laboratory R&D in advanced heat transfer fluids (HTF) & thermal storage systems
- FOA activities in solar collector and component development for use of molten salt as a heat transfer and storage fluid
- applications for all activities include line focus and point focus solar concentrating technologies



Relationship to Solar Program Goals

Storage Overview

1. Project Overview

b) Major FY08 Activities

- Advanced HTF development
 - novel molten salt compositions with low freezing temperatures (SNL)
 - nanofluids molecular modeling and experimental studies (NREL)
 - use with molten salt HTF in solar collector field (Abengoa)



Relationship to Solar Program Goals

Storage Overview

1. Project Overview

b) Major FY08 Activities (continued)

- Thermal storage systems
 - cost analysis and updates for 2-tank and thermocline storage (NREL/Bruce Kelly)
 - model development and analysis to support near-term trough deployment (SNL)
- Thermal storage components
 - facility upgrade to support molten salt component testing for freeze-thaw receiver testing (SNL)
 - long-shafted molten salt pump for parabolic trough and power tower thermal storage systems (Hamilton Sundstrand)



Relationship to Solar Program Goals

Storage Overview

1. Project Overview

b) Major FY08 Activities (continued)

- CSP FOA support
 - testing & evaluation support for molten salt component and field testing work (SNL & NREL)
 - advanced fluids & storage solicitation preparation (NREL & SNL)
 - proposal evaluation for new advanced HTF and thermal storage FOA (NREL & SNL)



Relationship to Solar Program Goals

Storage Overview

Project overview (continued)

c) Planned Milestones

- initiate nanofluids modeling studies & submit progress report, July 2008
- report on all cost updates for 2-tank and thermocline storage systems, September 2008
- thermal storage test facility restoration plan, June 2008
- prepare & complete advanced fluids/thermal storage solicitation, March 2008
- report on FOA technical support activities, September 2008



Relationship to Solar Program Goals

Storage Overview

Project overview (continued)

d) Budget Table

Agreement	FTEs	\$(K)	Subcontract \$(K)
Advanced fluids	3.2	661	0
Storage systems	1.6	474	25
Storage components	1.9	568	0
FOA storage support	1.0	300	0
HTF/TES solicitation	1.0	300	0

Relationship to Solar Program Goals



Storage Overview

Project overview (continued)

d) Budget Table

FOA Award	Company	Funding (K)
Molten salt pump	Hamilton-Sundstrand	362
Molten salt field testing	Abengoa	500

Relationship to Solar Program Goals



Storage Overview

Project overview (continued)

e) Personnel

- NREL: Greg Glatzmaier, Mark Mehos, Chuck Kutscher, Dan Blake, Joongoo Kang (post-doc), Yong-Hyun Kim
- SNL: Tom Mancini, Nate Siegel, David Raymond, Robert Bradshaw

Relationship to Solar Program Goals



Storage Overview

“...to make CSP cost competitive in the intermediate power markets by 2015 (~7¢/kWh with 6 hours of storage) and in baseload power markets (~5¢/kWh with 16 hours of storage) by 2020.”

2. Link to Program Plans & Goals

MYPP & Program Goals

- advanced HTF & storage systems directly address long-term goal of making CSP dispatchable for intermediate load, wholesale power generation
- higher temperature HTF directly addresses subprogram goals of 15.5% annual solar efficiency
- advanced HTF & storage systems directly address subprogram goal of \$20/kWh for thermal storage

FY08 Progress Report



Storage Overview

1. What has been accomplished thus far?

a) Overview & technical highlights

- advanced nanofluids R&D: post-doc hired in November 2007 & nanofluids modeling initiated
- molten salt formulations (Tom)
- thermal storage cost updating subcontract statement of work submitted to Bruce Kelly
- thermal storage test facility restoration plan (Tom)

FY08 Progress Report



Storage Overview

1. What has been accomplished thus far?

a) Overview & technical highlights (continued)

- FOA testing & evaluation support discussions initiated with awardees
- solicitation for R&D & demonstration of advanced HTF and thermal storage concepts prepared & reviewed by NREL, Sandia & DOE, completed early March 2008

b) Issues & costing (current level; projected end-year balance)

- to be presented in following presentations

FY08 Progress Report



Storage Overview

2. What will be accomplished in the 3rd and 4th Quarters?

- Continue current work & begin modeling studies to form stable, rigid nanoclusters
- molten salt plans (Tom)
- cost modeling and updating of thermal storage systems will be completed by Bruce Kelly
- thermal storage test facility restoration plan to be completed (Tom)
- DOE/GFO will conduct the final release of HTF/TES solicitation & make awards

FY08 Progress Report



Storage Overview

2. What will be accomplished in the 3rd and 4th Quarters? (continued)

- support GFO on HTF/TES solicitation proposal evaluations
- testing & evaluation support of FOA awards
- a) status of milestones
- to be presented in following presentations

FY08 Progress Report



Storage Overview

Future Activities

1. FY09 Planned Activities

a) follow-on work

- continued modeling & testing of nanoparticles
- advanced molten salts formulations (Tom)
- complete restoration of the thermal storage test facility (Tom)
- improve & enhance cost & performance models for thermal storage systems with specific focus on evaluating FOA demonstration technologies
- continued FOA testing & evaluation support, technical advising for current and upcoming fluids & storage awards

FY08 Progress Report



Storage Overview

Future Activities

1. FY09 Planned Activities

b) new directions

- develop new research directions in heat transfer fluid with desired liquid-phase range (10 °C – 500 °C)
- develop several new concepts in thermal energy storage
 - systems applicable to steam storage
 - entirely new ideas including novel phase-change or thermochemical concepts

FY08 Progress Report



Storage Overview

Future Activities

1. FY09 Planned Activities

c) budgets

Topic	FTEs	\$(K)	Subcontract \$(K)
Nanofluids	2.2	360	0
Advanced salts	tbd	tbd	0
Thermal test facility	tbd	tbd	0
Cost modeling	0.5	150	50
FOA support	?	?	0
New concepts	0.75	225	0

FY08 Progress Report



Storage Overview

Future Activities

1. FY09 Planned Activities

d) Milestones

- report on nanofluids modeling & experimental progress
- advanced molten salts
- thermal test facility restoration
- report on cost & performance modeling updates
- report on FOA testing & evaluation support of FOA contracts
- submit report summarizing new concepts in advanced fluids and thermal storage

FY08 Progress Report



Storage Overview

Future Activities

2. FY10 and Beyond Ideas

a) Future projects

- initiate long-term R&D in fundamental topics relating to thermal energy storage
- topics could include thermodynamic limitations, heat transfer and fluid dynamics
- topics are applicable to sensible, phase-change and thermochemical storage

c) Vision: laboratories continue to build strong internal R&D capabilities in thermal storage and provide effective support to the growing CSP industry