2008 Solar Annual Review Meeting

Session: Thermal Storage - Overview
Company or Organization: NREL & SNL
Funding Opportunity: Concentrating Solar Program

Greg Glatzmaier, Mark Mehos, Tom Mancini

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
- planned FOA activities for use of molten salt as a heat transfer and storage fluid
- applications for these 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 of molten salt as heat transfer fluid (Abengoa, Solar Millennium)

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 (SNL)
  - long-shafted molten salt pump (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)
  - 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
- submit 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)

e) Personnel

- NREL: Greg Glatzmaier, Mark Mehos, Chuck Kutscher, Dan Blake
- SNL: Tom Mancini, Nathan 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

- thermal storage directly impacts CSP dispatchability for intermediate load, wholesale power generation
- higher temperature HTFs address the goal of increasing annual solar efficiency (15.5%)
- advanced HTF & storage R&D directly address cost 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 & initiated modeling work
      - new molten salt formulations possess reduced freezing points
      - thermal storage cost updating statement of work submitted to Bruce Kelly
      - test facility restoration plan is being developed

FY08 Progress Report

Storage Overview

1. What has been accomplished thus far?
   a) Overview & technical highlights (continued)
      - solicitation for 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?

- begin modeling studies to form stable, rigid nanoclusters
- continued molten salt testing
- cost modeling and updating of thermal storage systems will be completed by Bruce Kelly
- complete thermal storage test facility restoration plan
- 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
- Initiate testing & evaluation support for FOA awards

a) status of milestones

- to be presented in following presentations

Future Activities

1. FY09 Planned Activities

a) Follow-on work

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

FY08 Progress Report

Storage Overview

Future Activities

1. FY09 Planned Activities

b) New directions

- develop several new concepts in thermal energy storage
  - systems applicable to steam storage
  - entirely new ideas including novel phase-change concepts

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

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