2008 Solar Annual Review Meeting

Session: Parabolic Troughs
Organization: NREL

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Project Description

- R&D activities at NREL and Sandia aimed at lowering the delivered energy cost of parabolic trough collector systems

- FOA awards to support industry in trough development

Relevance to Program Plans & Goals

Trough goals:

- Reduce collector cost from $260/m^2 to $160/m^2
- Increase operating temperature from 390°C to 450°C
- Reduce coating emittance to 0.07

Relevance of Activities:

- Supporting manufacturers in development of lower cost troughs
- Optical measurement support and improved coatings will increase collector efficiency
- New heat transfer fluids will allow higher operating temperature

FOA Trough Contracts

- Abengoa – advanced trough ($499K)
- Abengoa – polymer reflector (with Conductive Science, Inc.) ($448K)
- Alcoa – advanced all-aluminum trough ($399K)
- Solar Millennium – advanced high-temperature trough ($350K)

Budget

Project Beginning Date	FY07 Carryover	FY08 Budget	Total Budget
10/1/2003	$2.03 million	$2.57 million	$4.60 million

Agreement	FTEs	In-house $(K)	Subcontract $(K)
Solar Field	5.3	1,739	0
Power Cycle and Balance of Plant	0.3	99	75
Systems Integration	2.45	641	30
FOA Support	1.0	315	0
FOAs	--	--	1,695

Personnel

NREL: Chuck Kutscher, Tim Wendelin, Cheryl Kennedy, Greg Glatzmaier, Gary Jorgensen, Frank Burkholder, Judy Netter, Allison Gray

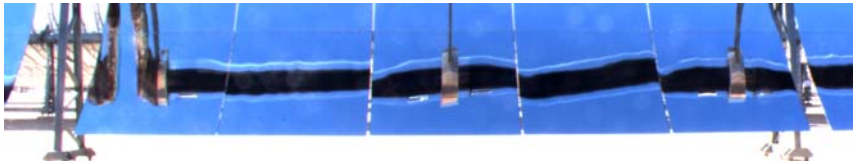
Sandia: Greg Kolb, Rich Diver, Tim Moss, Nathan Siegel, Bob Bradshaw

VSHOT Testing

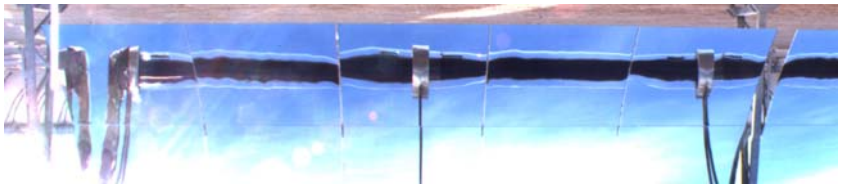
- Applied in field to test Abengoa collectors in Spain
- Used to help SkyFuel refine their new reflector design
- Enhanced capability, transferred to Solar Systems

TOP Alignment

- Tested at Saguaro and SEGS II-VII
- Testing takes 4 min/module (70 min/module when re-alignment required)

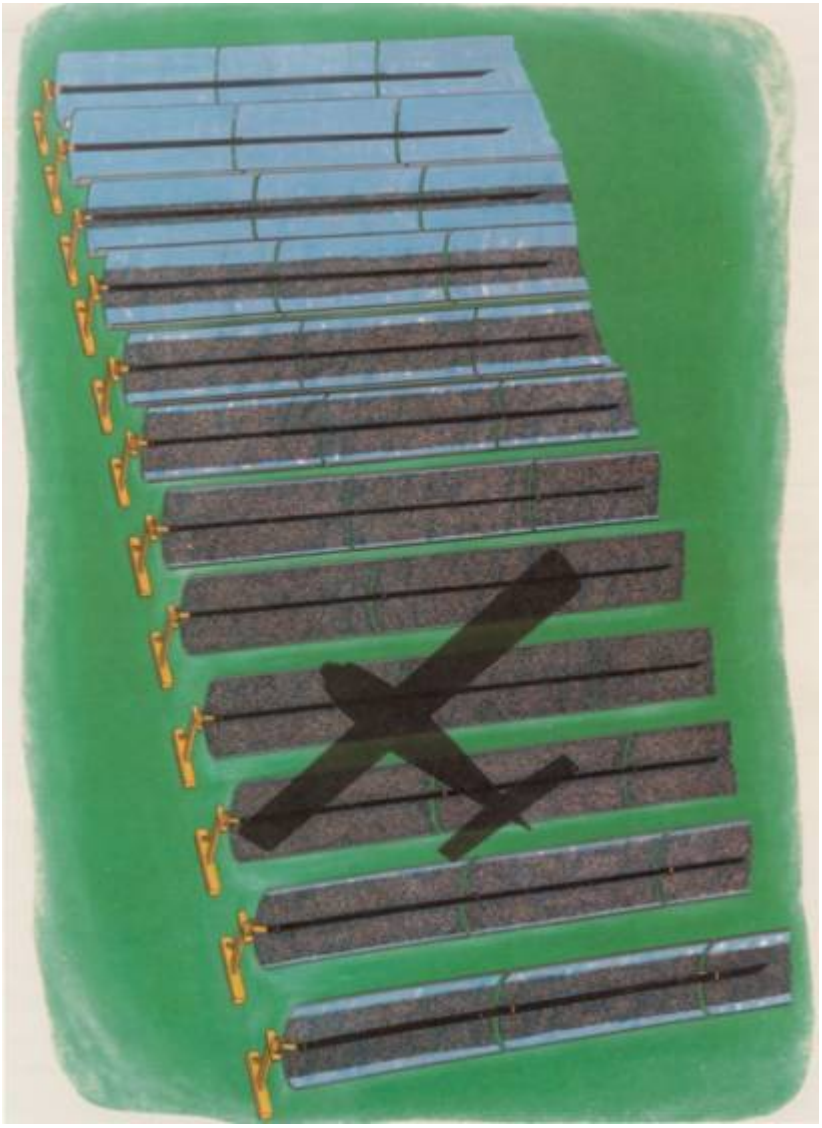


Before

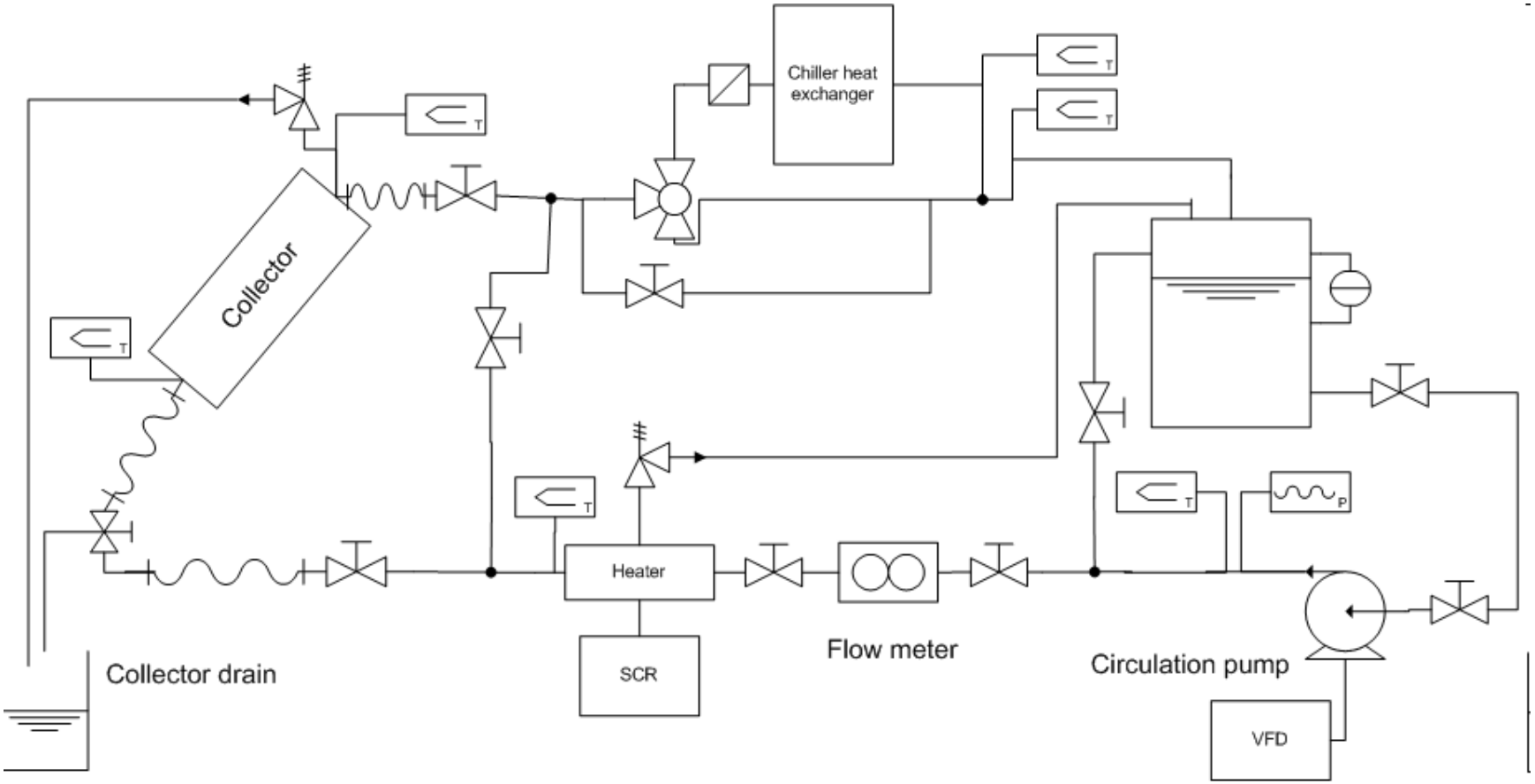


After

Distant Observer

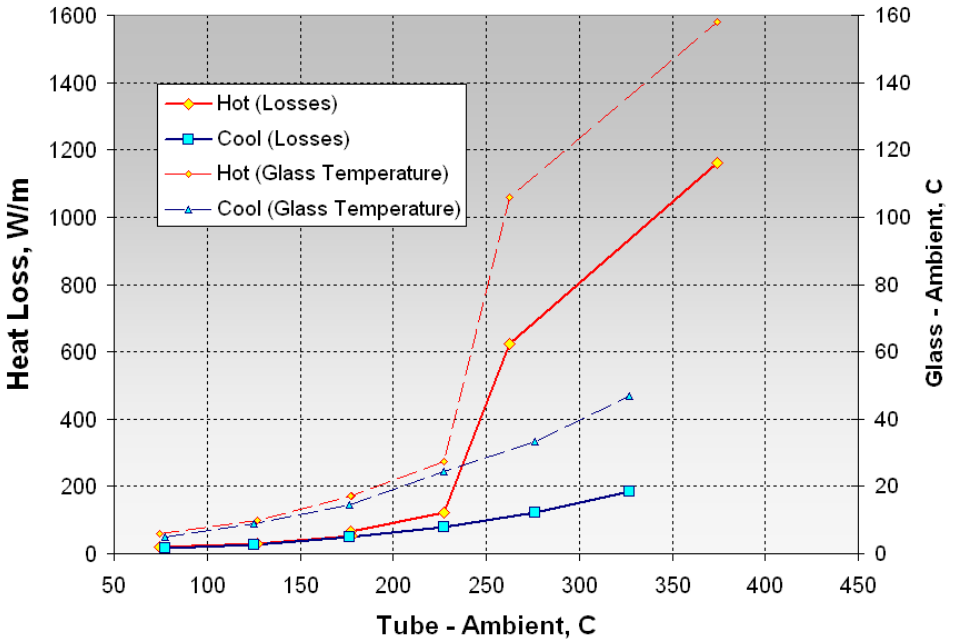


Total Collector Optical Efficiency Test Loop



Receiver Heat Loss Measurements

- Tested new Schott and Solel receivers
- Tested tubes from field with and without hydrogen contamination

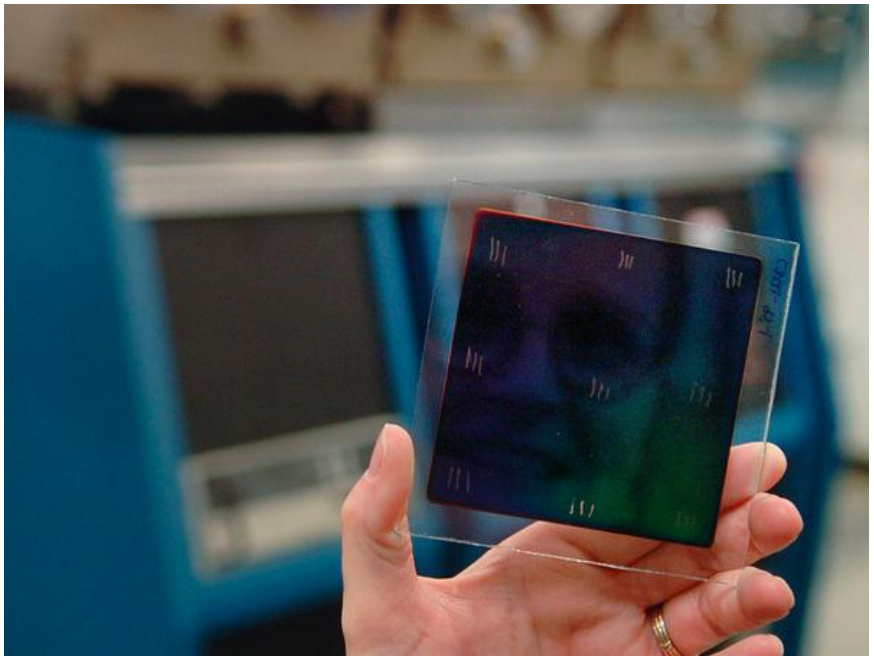


Field IR Receiver Measurements

- IR camera/GPS unit can measure glass temperature of 6,000 receivers in one day

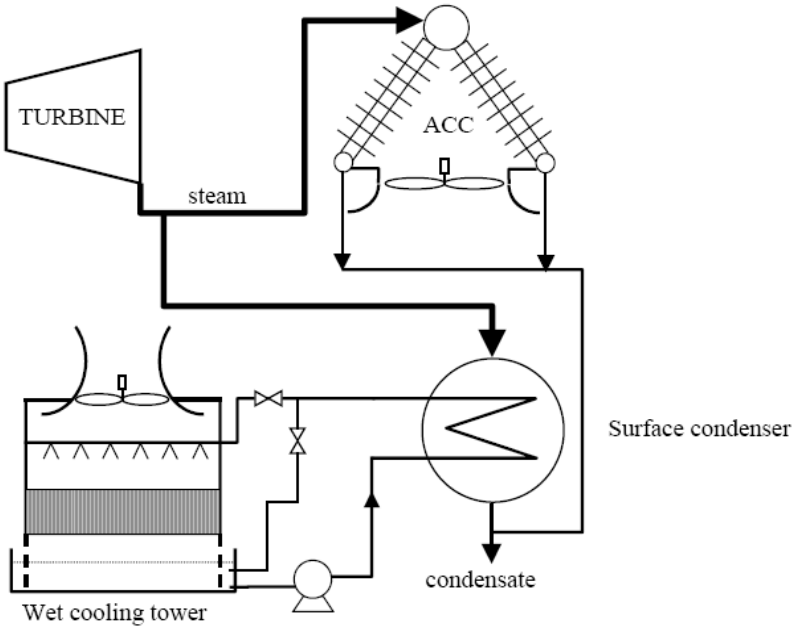
Optical Materials R&D

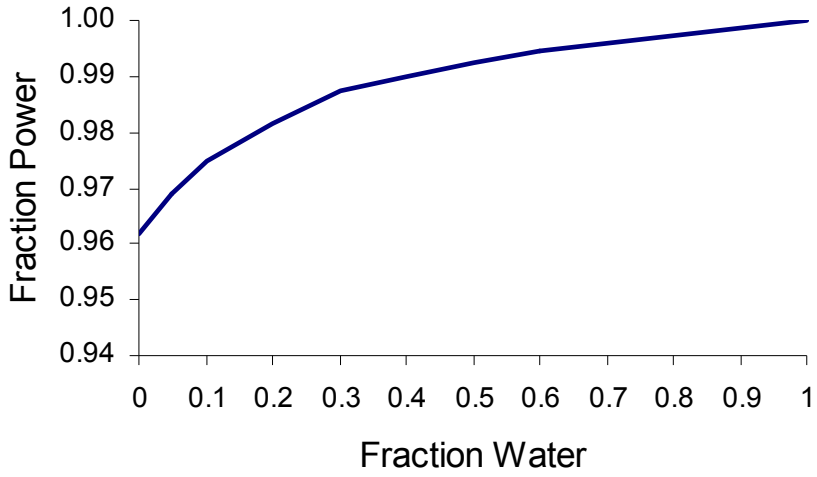
- Deposited improved solar selective coating with $\varepsilon = 0.07$, $\alpha > 95\%$, stable > 500°C
- Filed for patent (11/07)
- Negotiating with 2 potential licensees (1/08)



Report on Reducing CSP Water Usage

- Hybrid air/water cooling systems can reduce water use 80% with modest performance and cost penalties



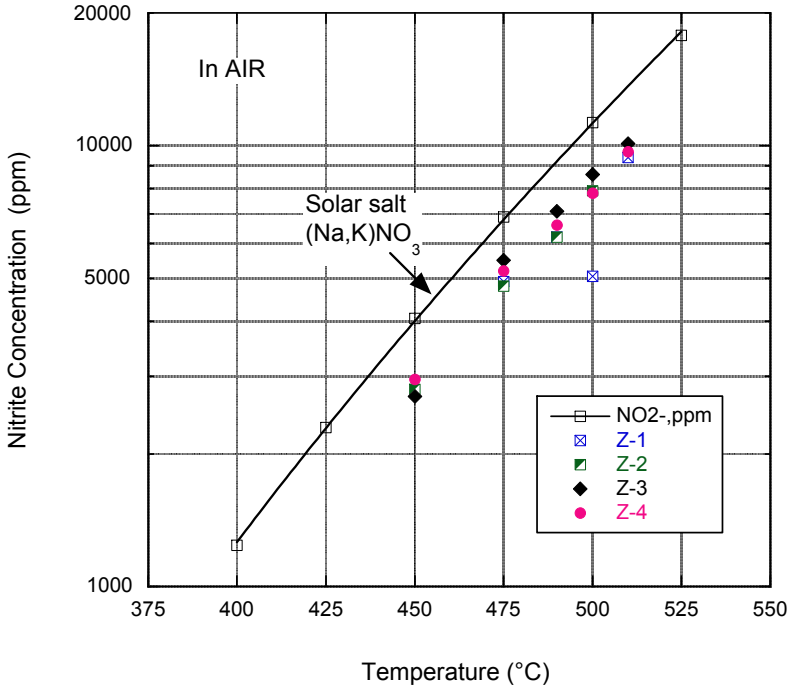


Improved Molten Salt Mixtures

- Blending four simple nitrate salts gives low freezing and high operating temperatures, good fluid properties

Mixture Composition vs. Solidification Testing
Liquid Mixtures Observed at T <100°C

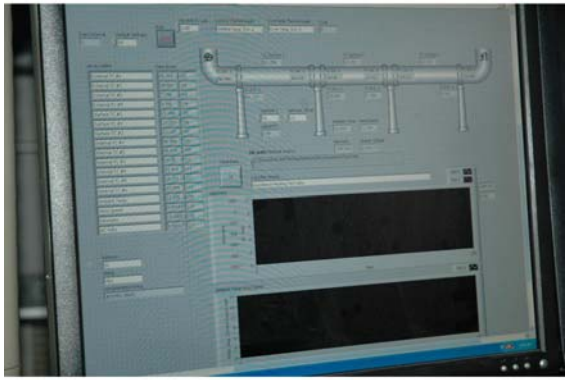
Chemical Stability Tracks
Solar Salt to 500°C



Receiver Impedance Heating Test

- Flow electrical current through receivers to preheat prior to flowing salt
- Can be used to recover from a salt freeze-up accident

Receiver Test Rig



Impedance Heating Controls

Milestones

Milestone	Date	Status
Lab tests of advanced receiver	Jan. 2008	Completed Jan. 2008
Train FPL staff on IR HCE survey	March 2008	Completed March 2008
Complete instrumentation and qualification tests of optical test loop	March 2008	Completed April 2008
TOP alignment tests at Saguaro	March 2008	Completed Nov. 2007
Organize trough sessions at SolarPACES	March 2008	Completed March 2008
Prepare report on CSP plant water usage	June 2008	Draft April 2008

Milestones (cont.)

Milestone	Date	Status
Data for receiver heat loss with inert gas mixtures	June 2008	On schedule
Report on H_2 mitigation and future plans	August 2008	On schedule
Report/paper on distant observer feasibility	September 2008	On schedule
Report summarizing industry support activities	September 2008	On schedule
Report summarizing FOA support	September 2008	On schedule

Issues and Solutions

- Delivery of new SkyFuel trough to NREL delayed; have obtained Gossamer frame to test
- Sagging of receiver tubes noted in TOP alignment tests at Saguaro; additional tests planned for fall 2008
- Greatly increased number of requests for support from existing and emerging industry and FOA contractors

FY09 Planned Activities

Follow-on efforts

- current R&D activities continuing
- additional transfer of VSHOT to industry
- updated cost models for troughs/thermal storage

New directions

- field measurements at Ausra CLFR installation
- outdoor wind load tests

Projected Milestones

- testing of distant observer system
- report on CLFR cost and performance

FY10 and Beyond Ideas

Future Projects

- demonstrate use of molten salt in the collector field
- develop larger aperture trough
- develop strategies to integrate trough-storage system
- extend trough test & evaluation capabilities to other technologies (CLFR, CPV and towers)
- explore high-voltage DC transmission lines to move CSP electricity eastward

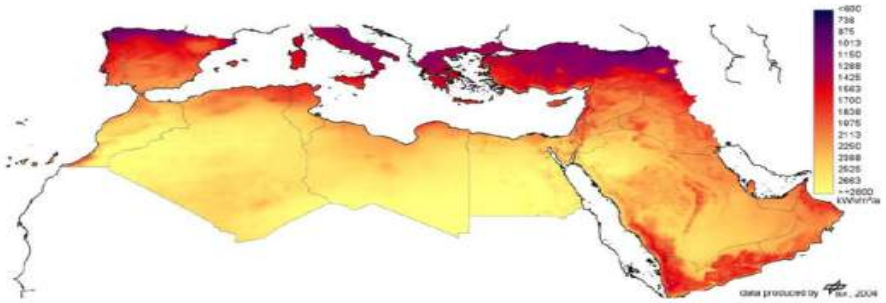
Outside the Box Ideas

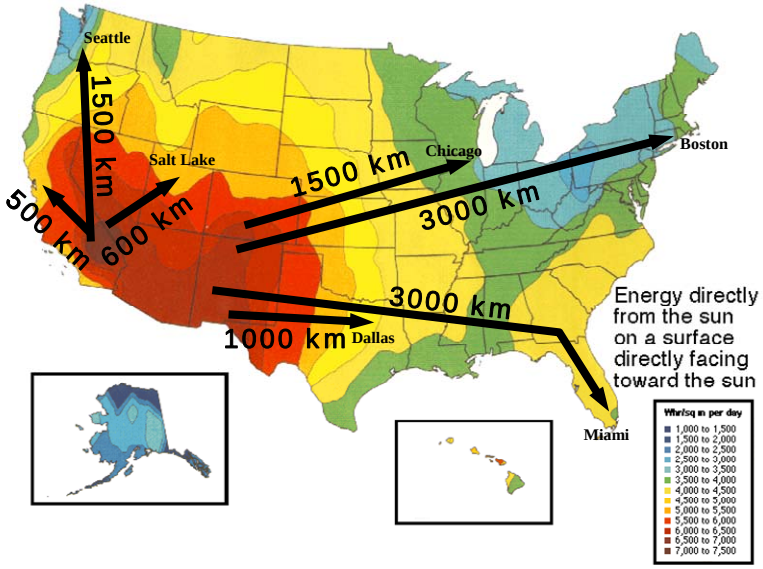
- explore adiabatic compressed air energy storage
- CSP/CPV hybrids

Vision of the Solar Future

- a mix of technologies with enhanced storage and transmission

Long Distance Transmission





Concentrating Solar Power for the Mediterranean Region," German Aerospace Center (DLR), 2005