

# **The California Design (CALDES)**

**A Geopressured-Geothermal System-of-Systems Renewable Energy  
Solution to the Impending Water Shortage Crisis in the West**

California-Nevada Section, American Water Works Association  
Fall Conference, 23 October 2007, Sacramento, CA

Dr. George S. Nitschke, P.E.



# CALDES Synopsis

## The California Design (CALDES): A Geopressured-Geothermal System-of-Systems Renewable Energy Solution to the Impending Water Shortage Crisis in the West

The CALDES systems concept is expected to provide a long term, profitable solution to the water shortage crisis in the West while reducing U.S. reliance on foreign oil. The systems design utilizes desalination of geopressured-geothermal (GPGT) brine reservoirs (short-term) and renewably powered coastal desalination (long-term). *The CALDES systems essentially recover a non-renewable resource (GPGT brine) and convert it into a renewable energy resource (solar ponds), which is then utilized to produce potable water via large scale seawater desalination.* A byproduct of the design is cost-effective recovery of collocated heavy oil (fraction of costs for conventional recovery processes), which provides a near-term increase in domestic oil availability while greatly enhancing the overall project economics.

The CALDES systems solution, deployed in California and/or Texas, is modularly extensible, from a single system, to tens of systems, etc. It is estimated that California's capacity is 1000+ CALDES systems, providing 5+ MAF/y potable water from coastal desalination.

*A feasibility study of the CALDES systems concept has been vetted/approved and published as George Nitschke's doctoral dissertation (Renewable Energy, Oct.2006).*



# Outline

## The California Design (CALDES)



What is it?

How is it profitable?

What is the status of its implementation?



# CALDES: *What is it?*

A design to recover Geopressured-Geothermal (GPGT) brines to convert into solar ponds for renewably powering coastal seawater desalination. Byproduct gas and H<sub>2</sub>O are used synergistically for cost-effective thermal enhanced oil recovery.

## ➤ GPGT Conversion Segment



15-17

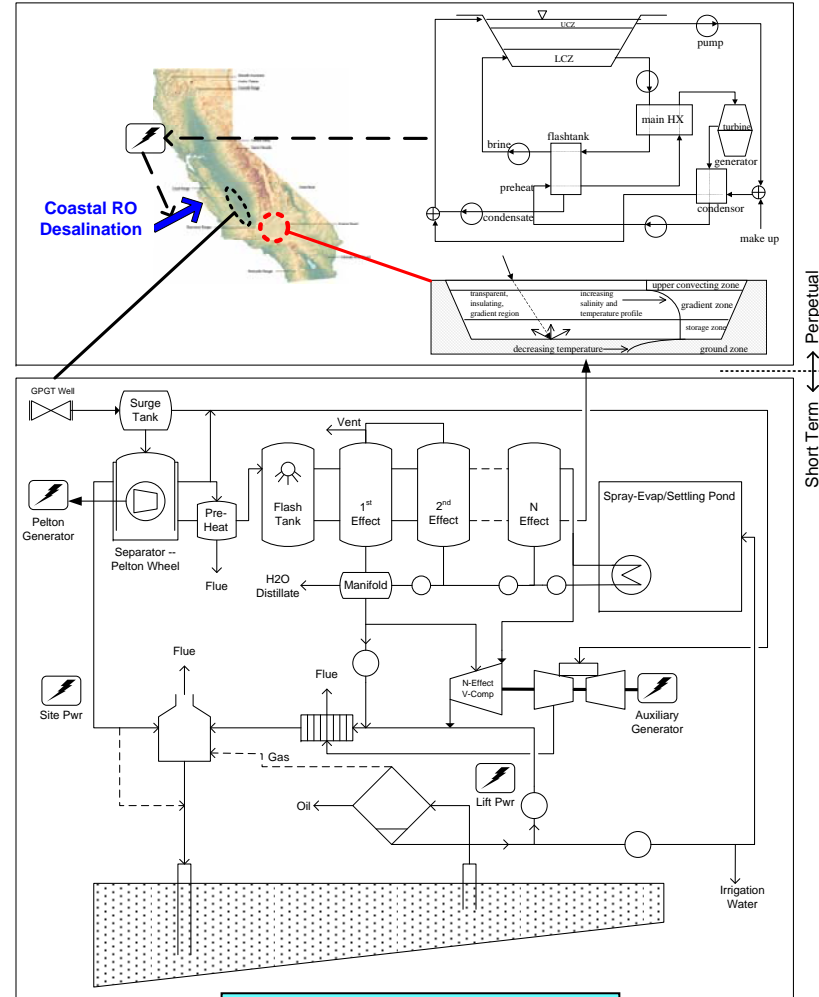
- Recover GPGT raw brine
- Promote thermal enhanced oil recovery (TEOR)
- Produce H<sub>2</sub>O and saturated brine

## ➤ Solar Energy Segment

- Use saturated brine to build solar ponds
- Use solar power for coastal desalination

## ➤ Integrated Water & Energy

- Segment-synergy is essential (salt!)
- California, Texas deployment
- Flexible configurations (1 of 7 shown)
- Modularly extensible
- **Environmentally sustainable**
- **Economically profitable**



U.S. Patent Re. 36,282;  
Other Patents Pending



# Notional CALDES Integration in California

## GPGT Conversion Systems

- Recover Heavy Oil
- Produce H2O Distillate
- Provide Solar Pond Salt

## Solar Energy Systems

- Solar Pond Power
- Renewably Power Desalination


## Fully Integrated Solution

- 5+ MAF/y
- CA Water Remediation
  - Bay-Delta
  - Salton Sea
  - Groundwater
  - CO River Reallocation?





# CALDES Summary

- In California, CALDES will help resolve municipal water shortfalls in an environmentally sustainable and economically sound manner
  - 5+ MAF/y renewably powered seawater desalination
  - Modularly extensible (from single to multiple systems)
- Fully deployed in California and Texas, a CALDES (and TEXDES) implementation will help resolve the impending U.S. water crisis   
18
  - Municipal demands met with renewable seawater desalination
  - Enabling environmental restoration (surface and ground water)
- CALDES will help strengthen the U.S. energy posture
  - Reduced reliance on foreign oil (increase in domestic availability)
  - Distributed, renewable power instantiation (solar pond systems)



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# CALDES: *How is it profitable?*

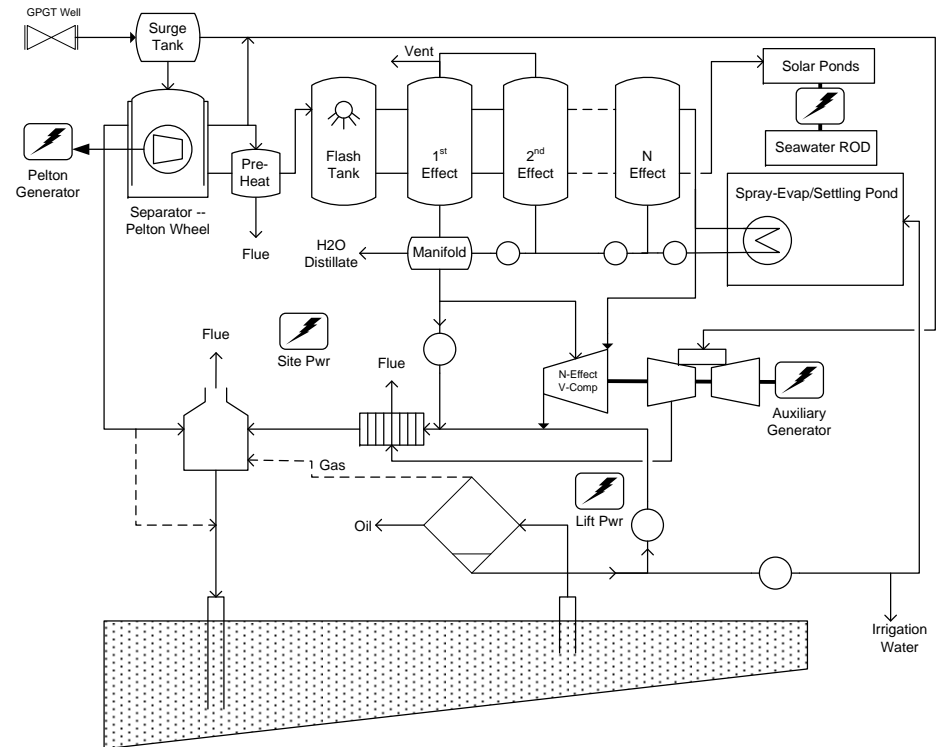
## ➤ The CALDES profitability is greatly enhanced by synergistic TEOR

- CALDES TEOR method only a fraction of conventional TEOR recovery costs
- Circumvents conventional problems
  - Distillate-quality TEOR H<sub>2</sub>O supplied by system
  - TEOR gas supplied by GPGT brine
  - Allows for distributed v. centralized steam-flooding

## ➤ Using the end-brine for solar ponds is a synergistic outlet for the GPGT salt

- Saturated brine outlet (vs. reduction to solid salt) doubles the CALDES TEOR productivity
- The increased TEOR plus the market value of renewable energy systems more than offsets the costs to build the solar system segment
- Solar pond usage also avoids the quantity limitation of the conventional salt market

## ➤ CALDES systems synergy essentially establishes the solar segment (solar ponds and desalination plants) as a revenue-neutral byproduct of the cost effective TEOR of colocated heavy oil

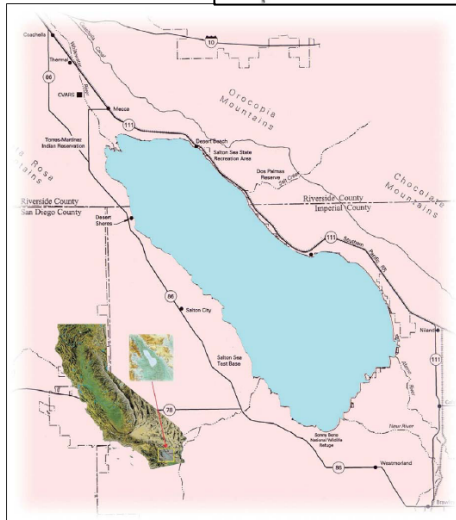
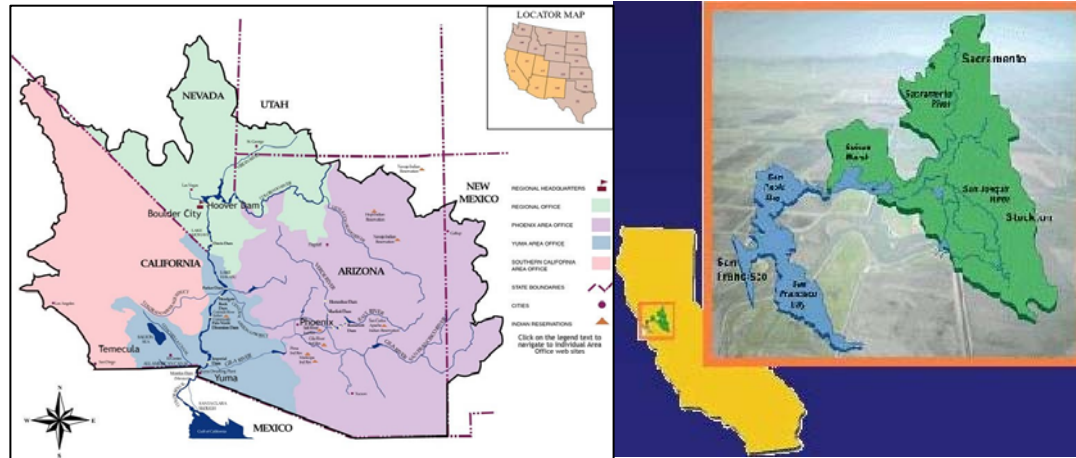


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# CALDES: More on Profitability

“Profitability” of a drought-proof solution to key water problems (e.g., bond relief).



Summary of Impacts For Noted Examples Against CALDES Benefits

Item	List of Issues	Water at Issue (MAF/y)
Colorado River	river delta habitat destruction, salinity damage, regional and irrigation demands, litigations	0.8 [1]
Salton Sea	migratory fowl habitat, endangered species, recreation, eco-balanced irrigation	0.5 [2]
Bay-Delta	environment, species preservation, agriculture, water quality, urban demands, litigations	0.6 [3]
Groundwater (DWR Bulletin 118)	currently overdrawing ~2 MAF/y to meet state's demands, drought year impacts	2.1
<b>Total Noted California Water Deficit →</b>		<b>-4 MAF/y</b>
CALDES	renewably driven coastal seawater desalination	+5 MAF/y [4]
Notes	[1] based on current California overdraw of Colorado River allocation [2] based on minimum inflow set in the Salton Sea Reclamation Act of 1998 [3] EWA amounts plus groundwater reserve per CALFED Bay-Delta Authority [4] Potential improvements (e.g., +25%: GPGT wells, flow rate, life; +10%: ROD membrane efficiency, SP operations) could double the water to ~10 MAF/y	



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# CALDES: *Implementation Status?*

## ➤ **Recent efforts / progress to-date**

- Dissertation published (Nov. 2006)
- Exploratory meetings with CA oil operators (Dec.2006)
  - Affirmed CALDES TEOR projections (cost savings, performance)
  - Apparent lack of interest in renewable energy, e.g., solar ponds
- Response from Gov. Schwarzenegger's office (Feb.2007)
  - Director Snow identified Dr. Fawzi Karajeh (DWR) as POC
- Technical Interchange Meeting at USBR Denver (Apr.2007)
  - Attended by USBR, telecon support by DWR, TWDB, Sandia
  - Good feedback, addressed items of concern/interest
- Latest patent filing (Summer, 2007)
- Raising awareness (ongoing, e.g., this AWWA conference)
- Formulation of Good Earth Mechanics, LLC (Fall, 2007)
  - Private entity to own and promote CALDES intellectual property
  - Reviewing several models for CALDES launch
  - Currently efforting "Integrator" model (more on later slide)



# Challenges / Findings Thus Far

- **Limiting type responses / reactions to the CALDES concept**
  - CALDES credibility
    - “If it’s such a good idea, how come no one has thought of this before?”
    - “You want us to believe we can solve the problem AND make money?!?”
  - Confusion regarding Geopressured-Geothermal resource
    - Mistaken as hot-rock geothermal (i.e., magma proximity, hydro-/petro-thermal)
    - “We know all about *geothermal energy*.” – **GPGT NOT THE SAME!**
  - Institutional inertia
    - Budget limitations (e.g., funding realities Re renewables)
    - Wheels-in-motion, funding allocated for other proposed solutions
- **Overarching systems engineering/management function to solve the complex water & energy crisis in the West does not currently exist.**
  - The individual stakeholder agencies have their own viewpoints, but an oversight management function across the entire enterprise does not exist.
  - The lack of this systems engineering oversight function is a key impediment to achieving a truly integrated solution.
  - The CALDES systems concept presents a construct on which this critical oversight and management function could take shape.



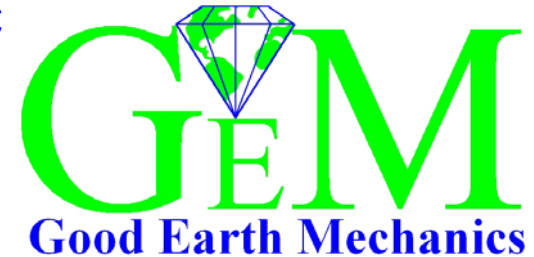
# CALDES Implementation: Current Approach

## ➤ Integrator model

- **Integrator licensed to implement CALDES technology**
  - Lease GPGT Conversion segment equipment
  - Provide cost-effective TEOR steam to oil operator on their lease
  - Establish/market Solar Energy segment infrastructure for end-customer
    - ⇔ E.g., Solar-Renewable Electricity facilities for electric utilities
    - ⇔ E.g., Renewably powered coastal desalination facilities for municipalities

## ➤ Role of Good Earth Mechanics (GEM), LLC

- **Newly formed LLC**
  - Owner of CALDES intellectual property
  - Association of subject matter experts
  - Monetized by proceeds from CALDES
- **Provide subject matter expertise support to the Integrator**
  - TEOR, Solar Ponds, GPGT systems, coastal desalination, etc.
  - Liaison support for Integrator's engineering functions
- **Continued R&D to improve/optimize the CALDES deployment**



For further information, contact George Nitschke at: [george.nitschke@comcast.net](mailto:george.nitschke@comcast.net)



# *Backup Material*



# The GPGT Resource

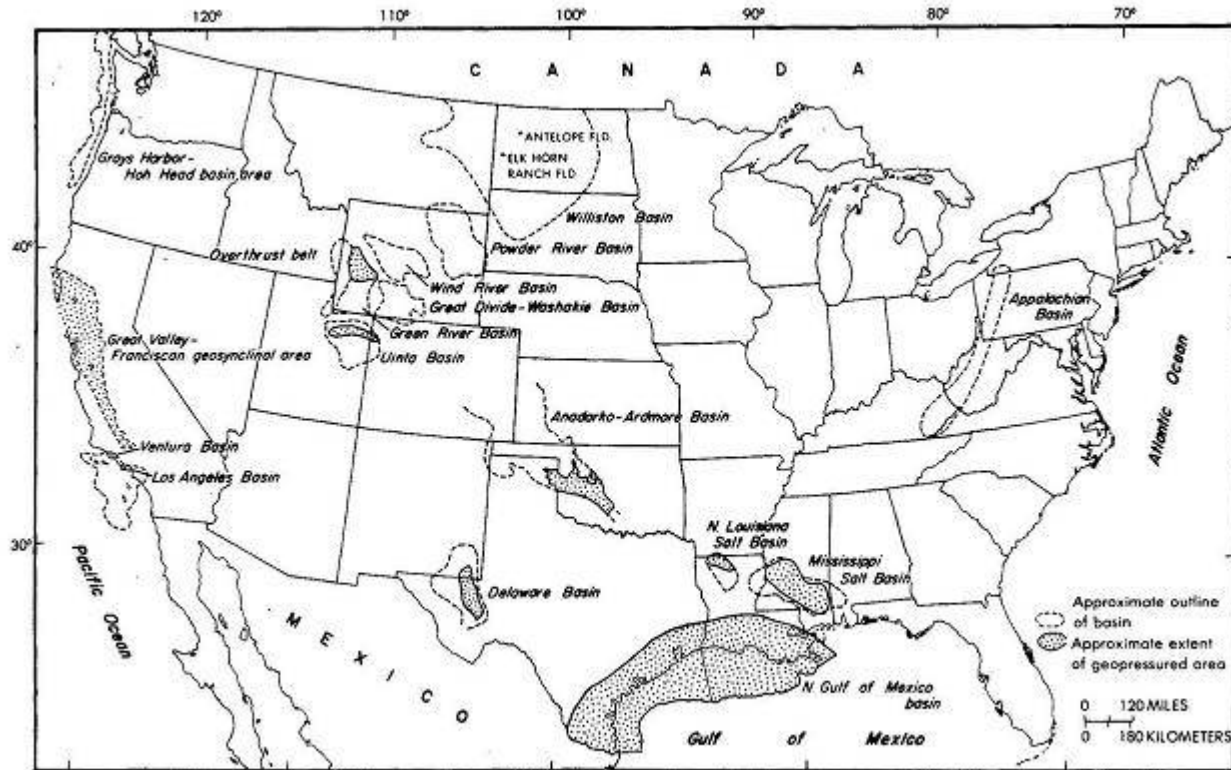
***Geopressured-Geothermal energy (GPGT) is an immense energy resource that remains relatively untapped throughout the world***

- **High pressure, high temperature, gas cut, brine reservoirs**
  - wellhead pressure: 1000–4000 psi
  - brine temperature: 250–400°F
  - GPGT brines contain 20–100 scf/bbl natural gas
  - normally found at depths greater than 10,000 feet
  - can be produced at high flow rates: 20,000–40,000 bbl/day
  - GPGT brines contain 15,000–200,000 ppm dissolved solids, typically 85% NaCl
  - outstanding flow longevity (Dept. of Energy flow tests, Gulf Coast region)
- **The recoverable GPGT energies are**
  - thermal (heat exchange with brine)
  - mechanical (flowing pressure at wellhead)
  - chemical (natural gas)
- **U.S. GPGT regions are strategically collocated**
  - California/Gulf Coast GPGT collocation with water crisis regions (e.g., DOI “Water 2025”)
  - GPGT collocation with medium-to-heavy U.S. oil reserves (key for CALDES)

**Not to be confused with “*hot-rock*” geothermal energy**



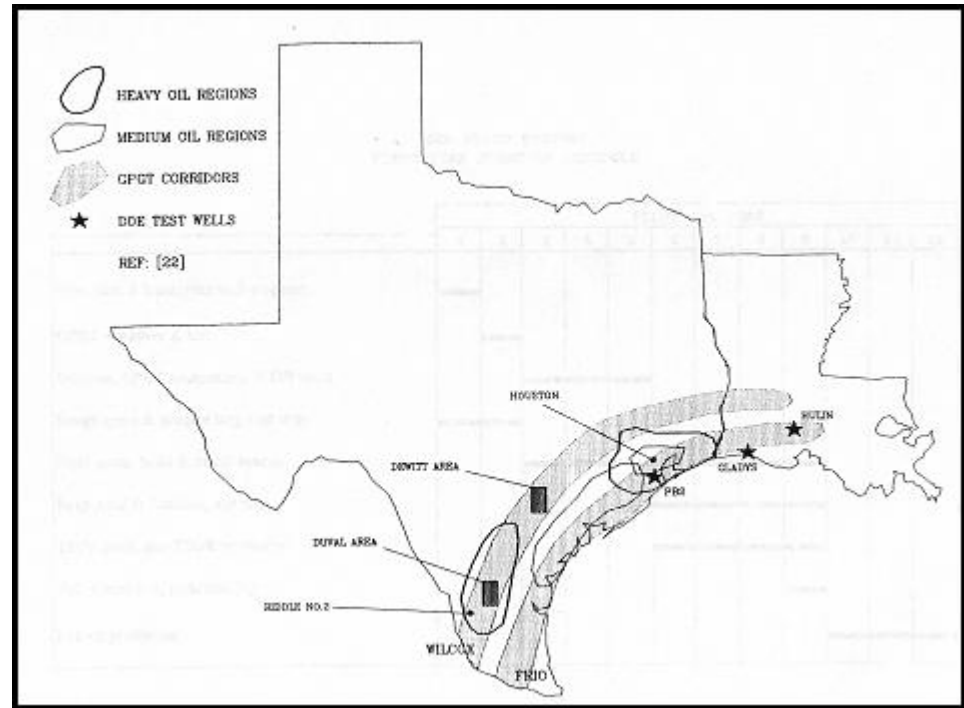
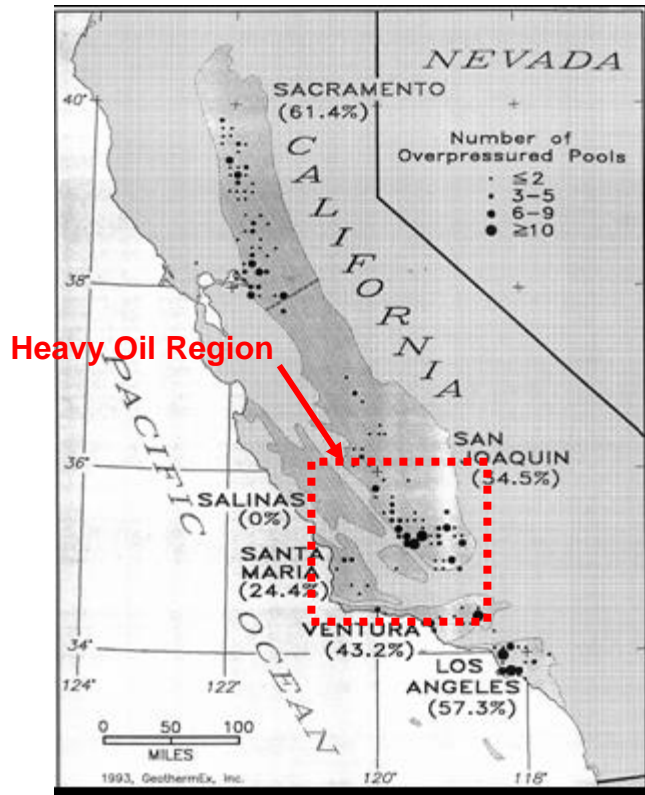
# The GPGT Resource



**U.S. GPGT Regions**



# The GPGT Resource

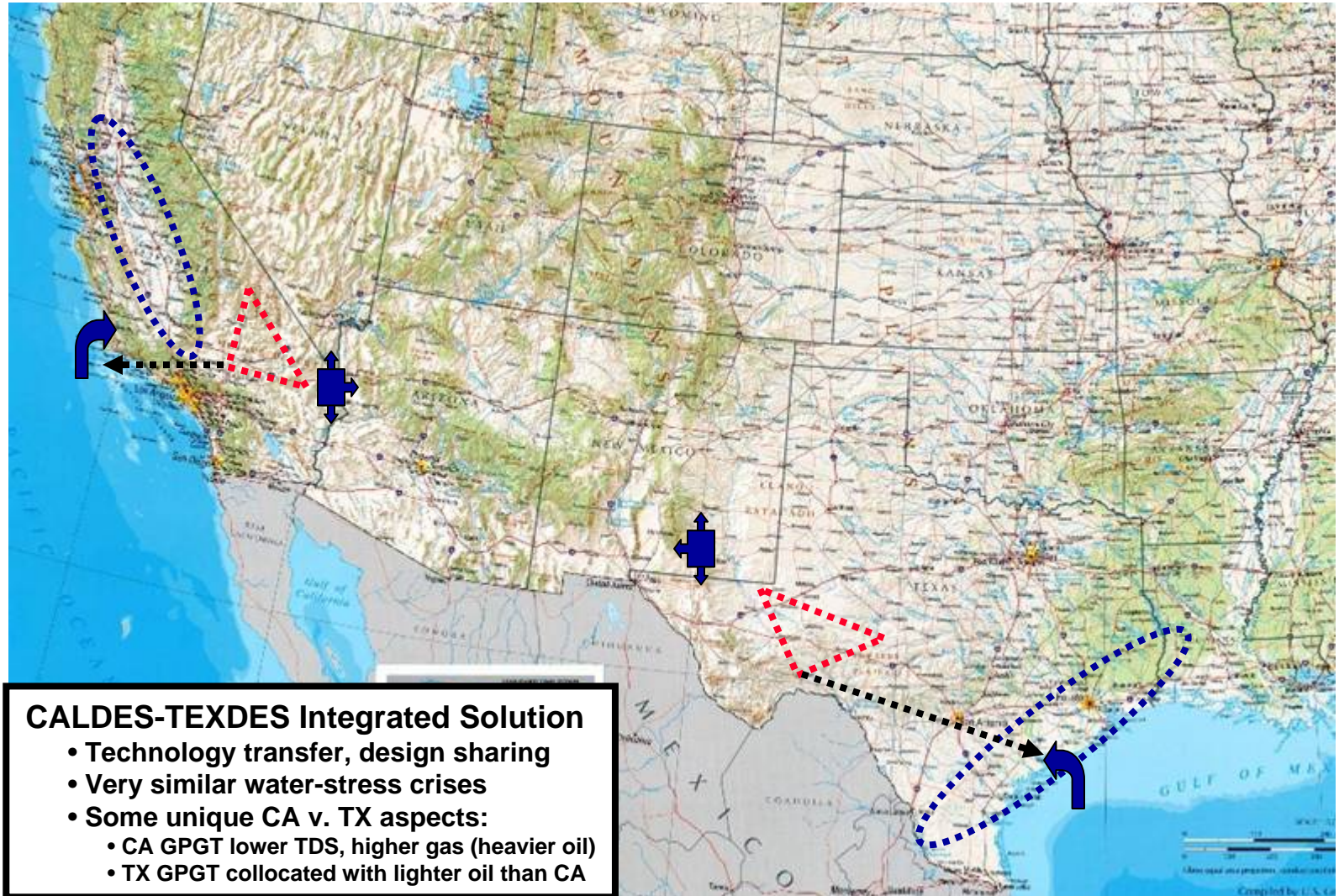


## U.S. GPGT and Heavy Oil Collocational Aspects





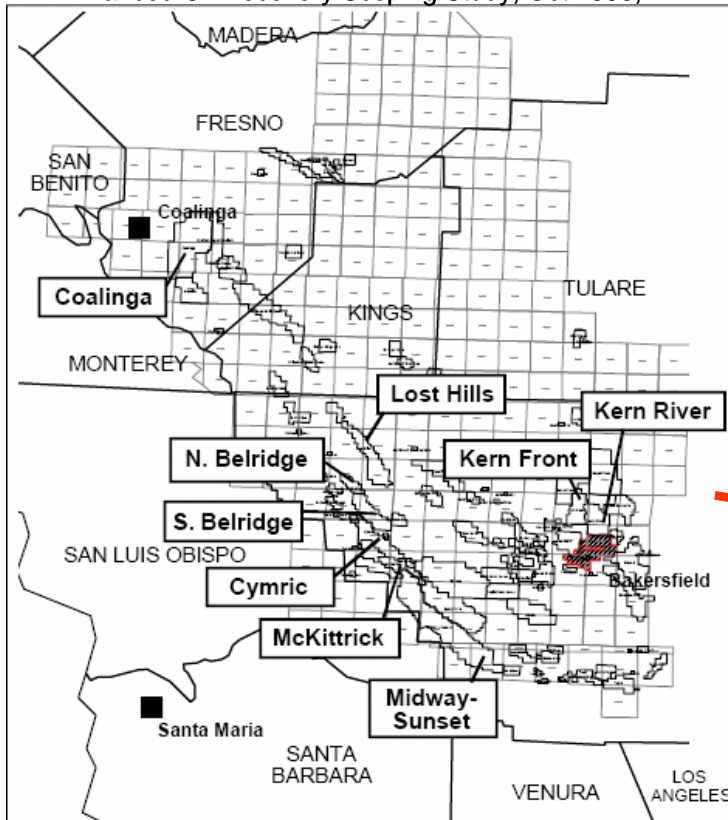
# CALDES & TEXDES for the U.S.



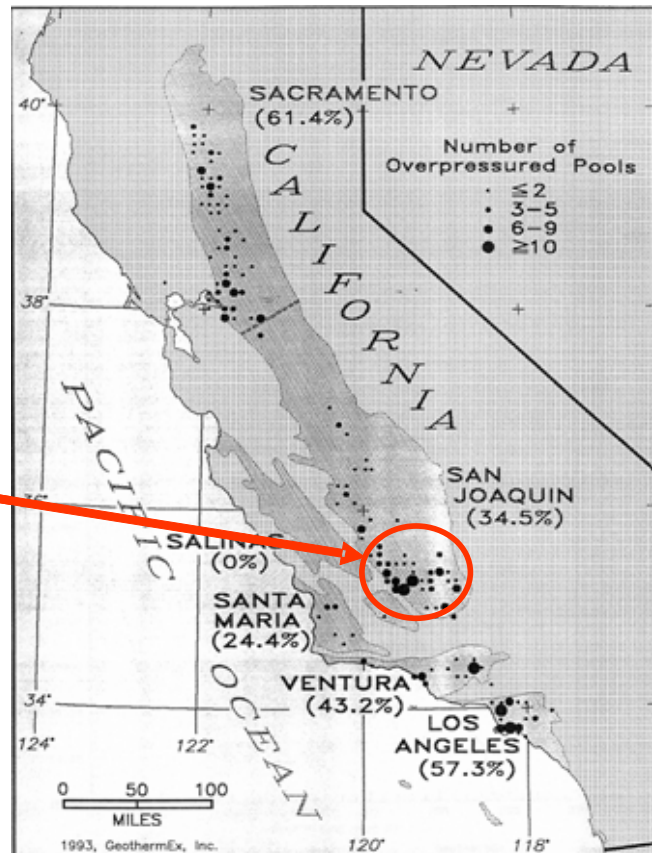


# Pilot Project Candidate Locations

Enhanced Oil Recovery Scoping Study, Oct.1999, EPRI



Survey of Potential GPGT in CA, Mar.1993, GeothermEx



**South Texas GPGT fairways will also provide candidate locations for a Texas Pilot Project**



# Governor Schwarzenegger / DWR Director Snow Letter

STATE OF CALIFORNIA – THE RESOURCES AGENCY

ARNOLD SCHWARZENEGGER, Governor

**DEPARTMENT OF WATER RESOURCES**

1416 NINTH STREET, P.O. BOX 942836  
SACRAMENTO, CA 94236-0001  
(916) 653-5791



FEB 15 2007

Mr. George S. Nitschke  
15 Andrew Drive  
New Ipswich, New Hampshire 03071

Dear Mr. Nitschke:

Governor Arnold Schwarzenegger has asked me to respond to your letter of December 6, 2006, and the accompanying dissertation excerpts addressed to Mr. Cameron Durckel, District Director at the San Diego Office of the Governor.

Thank you for informing us of your innovative system design addressing water and energy challenges in California. The Department of Water Resources (DWR) agrees that water desalination has the potential to curb a water crisis in the West. As you might be aware, the State of California is exploring a number of water management strategies to meet its future water demand. Water desalination is one of the strategies currently being considered as part of a balanced water portfolio to help meet the State's existing and future water needs.

As a part of the State's effort to support local decision makers explore and evaluate desalination as a water source option, DWR is providing grants to 48 desalination projects statewide, including research and development, feasibility studies, pilots, and demonstration projects. These projects are expected to help advance desalination on key issues including environmental, economic, energy, regulatory and public health.

Several grant-funded projects are related to your research interest, namely the use of solar and geothermal energy sources for water desalination. Summaries of the grant-funded desalination projects can be found at <http://www.owue.water.ca.gov/recycle/>.

If you have any further questions or need additional information on water desalination activities in California, please contact Fawzi Karajeh, of DWR's Office of Water Use Efficiency and Transfers, at (916) 651-9669 or by e-mail at: [fkarajeh@water.ca.gov](mailto:fkarajeh@water.ca.gov).

Sincerely,

A handwritten signature in black ink, appearing to read "Lester A. Snow".

Lester A. Snow  
Director

cc: Governor's Office  
The Resources Agency