



U.S. Department of Energy
**Energy Efficiency
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Inorganic Molten Salt Thermal Storage R&D

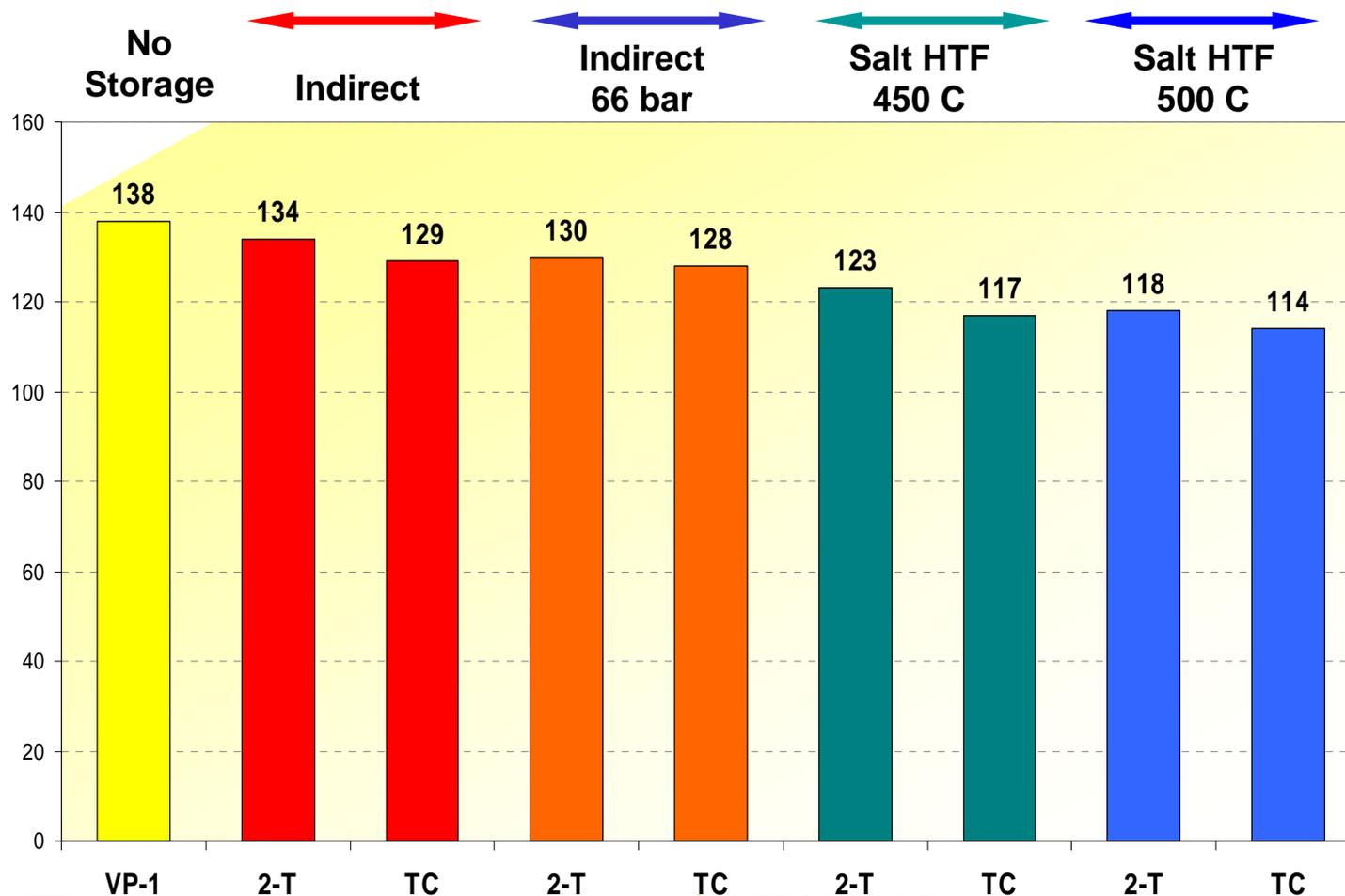
Doug Brosseau, Sandia National Laboratories

**Trough Workshop
February 13-14, 2006**





Thermal storage is good economic sense!



LEC \$/MWh
50 MWe
6 Hr Storage

2-T: 2-Tank
TC: Thermocline





- **Thermal storage is good!**
- **Thermal storage with molten salt is good!**
- **Direct thermal storage with molten salt is better!**
- **Thermocline-based direct thermal storage is best!**
- **We still want to do this in parabolic trough plants.**
- **We are willing to spend some money to get there.**
- **We need a guiding process to do the right things...**



- Key questions
- What we have wanted to do
- What should come next for TES R&D efforts
- Still... recommend utilizing Stage-Gate concepts for planning and execution





- **Do the 1999-2001 assumptions still make sense; are we on the right track?**
- **What is the best molten salt HTF formulation; does it make sense in a solar field??**
- **Can we go to 450C; is attempting 500C realistic based on what we know?**
- **How to deal with calcite formation issues noted in FY04 testing?**
- **Have we adequately addressed all salt/oil and salt/metal interactions?**
- **Have the key commercial-scale engineering considerations been addressed?**
- **When/how will we address balljoint design, seals, testing?**
- **When/how do we address freezing, freeze protection methods, freeze recovery? This applies to the solar field piping, valves, balljoints, HCEs in particular.**
- **What is the best approach to demonstrate and deploy this TES concept? How can we fund and accelerate the APS demo?**
- **Do we have confidence in our current economic/performance models and the input assumptions we use??**
- **Are there other alternatives we should be looking at?**



- **TES R&D Plan (August 2004) based on FY01-FY04 work**
- **Plans and challenges rolled out in DOE reviews since then.**
- **Tasks recommended (near-term):**
 - Nitrate salt studies
 - Engineering evaluations for commercial-scale considerations
 - Mitigation/control of calcite formation issue
 - APS TES final design and implementation



Nitrate Salt Studies

- **Objective**: To develop and improve ternary nitrate salt formulations.
- **Funds**: Very little actually planned/approved in FY05 (about \$5k late in FY05).
FY06: \$50k-\$75k balanced against other work
- **Staffing**: Brosseau/Bradshaw
- **Status**: Detailed draft task plan completed. Bob Bradshaw and Doug Brosseau have started these investigations, in a focused way.





What Happened??

Engineering Evaluations

•**Objective**: Engineering assessments of the requirements for commercial operations. The FY04 report documented key considerations.



•**Funds**: Nothing planned or approved. About \$1k of actual effort late in FY05 for plans.

•**Status**: Preliminary task plan completed. Bob, Doug, Bruce Kelly(?) key staff when this work is approved and funded.





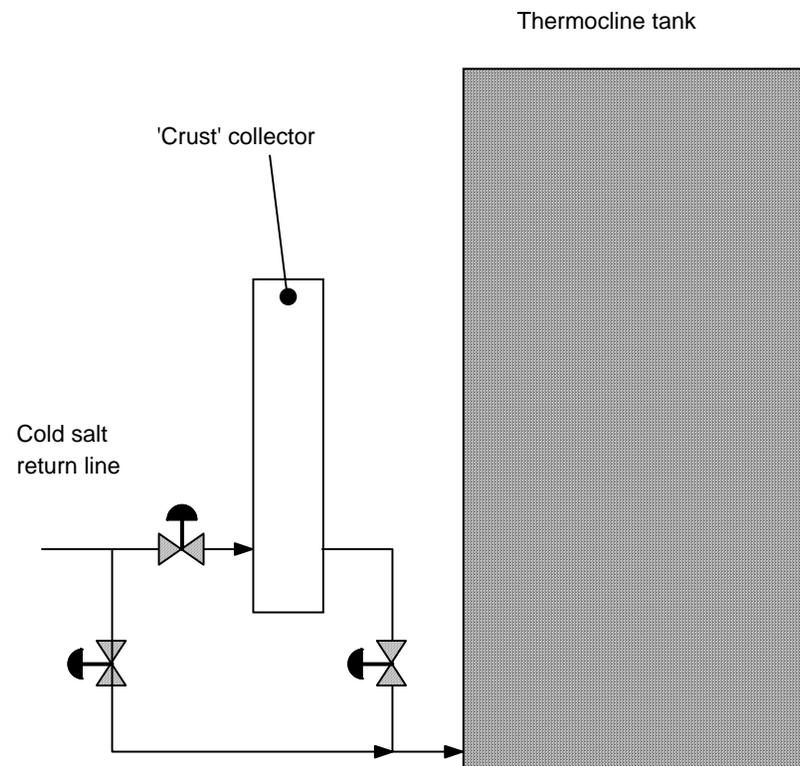
What Happened??

Calcite Mitigation and Control

•**Objective:** Investigate phenomenon; develop and test methods to control. Issue noted during thermal cycling tests.

•**Funds:** Nothing planned or approved. No actual effort or funds FY05 or FY06.

•**Status:** Basic task plan in place, based on FY04 documented results. Bob and Doug are key personnel for this effort.





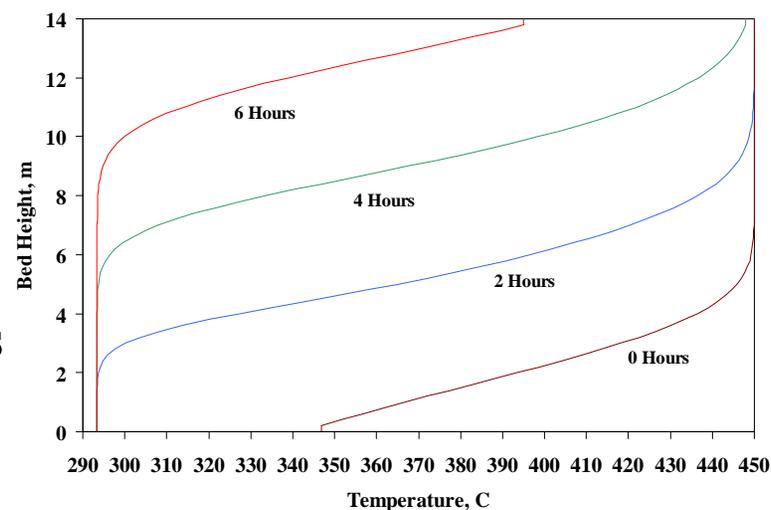
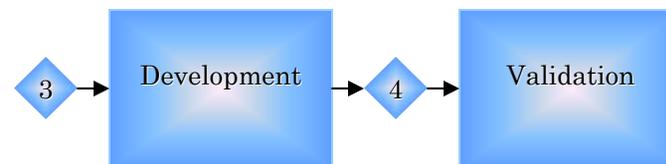
What Happened??

APS TES Design & Modeling

•**Objective:** Design and install thermocline TES at APS 1-MWe trough plant.

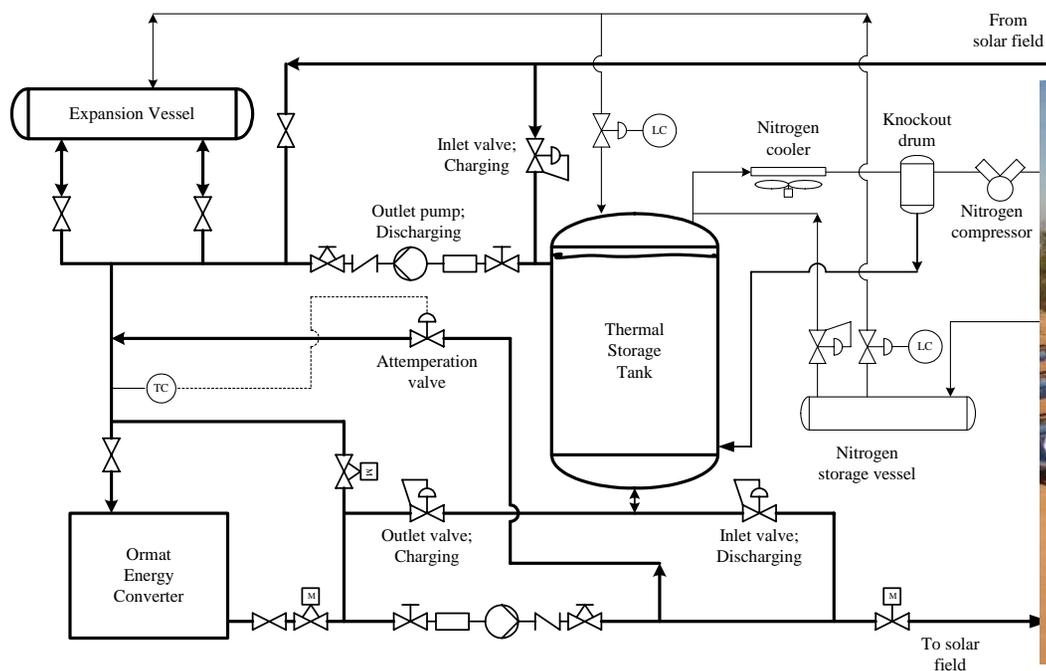
•**Funds:** Only early in FY05 (about \$35k) for preliminary design and review, and for Kolb TRNSYS modeling later in FY (about \$70k).

•**Status:** Basic design complete (Bruce Kelly), with cost estimates. TRNSYS models support going forward with TES at APS. Need to obtain performance data to validate.





- **Done:** design, cost estimates, supporting TRNSYS models
- **Cost share partnerships, ownership, yet to be determined.**



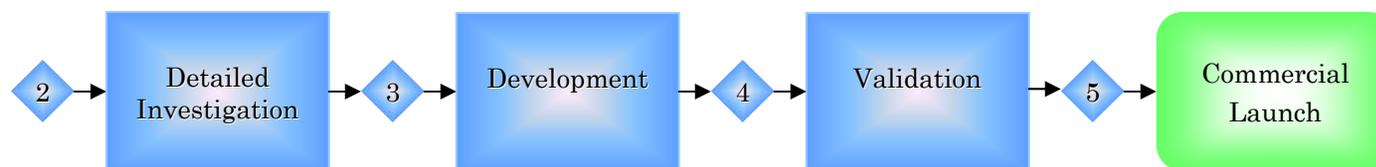


Same Recommendations As Last Year!!

- **Draft TES R&D Plan** includes a number of activities:

	<u>Stage:</u>
• Molten nitrate salt studies	2
• Engineering evaluations for commercial operation	2
• Mitigation and control of nitrate salt calcite formation	2
• Evaluation of salt/oil and salt/metal interactions	2
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• Trough-related valve & instrumentation loop testing	3
• Trough interconnect (balljoint) testing in molten salt environments	3
• Freeze protection development and testing with nitrate salts	3
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• APS organic Rankine cycle thermocline TES System	4
• Field-scale molten nitrate salt TES development	5

- **Planning of these activities would greatly benefit from stage-gate review.**





- **Critical review of molten salt in trough fields & TES**
- **Coordinate with trough industry partners**
- **Stage-Gate Go/No-go review and decisions**
- **Update TES R&D Plan for FY07 scope**
- **Update APS TES Plan for FY07 partnerships and funding**