Salinity Gradient Solar Ponds
Proposed Initiative for Chloride Control

*Update* to the Red River Valley Association
Shreveport, LA Convention
21 February 2013

*Revised: 31 October 2014*
GEM is proposing to use the salt contaminating the Red River Basin to construct SGSP systems for the production of renewable energy.

- Cost effective, integratable renewable energy (solar *thermal* electricity)
- Unlike wind or other solar systems, SGSPs can deliver continuous power
- SGSP construction requires a *lot of salt* (typically 170,000 tons per MW)
- The Red River chloride control *challenge* provides an SGSP *opportunity*

**Transition the Red River Basin chloride control project into a renewable energy solution**
GEM SGSP Proposal

GEM Team & Salinity Gradient Solar Ponds

SGSP proposal for Truscott, Red River region

Status of the SGSP initiative
• 16+ years SGSP development at the University of Texas El Paso (UTEP)
• Engineering data & models
• Proprietary practices & processes
• Patent pending methods & components
• Vendor relationships
Our Technology:
Salinity Gradient Solar Ponds (SGSP)

- Collector / storage / delivery all in one
- Robust, large-scale “thermal battery”
- Reliable base-load renewable energy
Wind systems typically operate 25% – 40% of the time (capacity factor, CF), producing power when extra power is often not needed (e.g., middle of the night). During hot periods when demand is highest, often winds are at their lowest levels. Utilities must have quick starting power plants ready to back up the wind generators at all times and to maintain power grid stability if the winds drop off suddenly.

Conventional solar power systems are dependent on the sun’s position and cloud cover, with typical solar systems having a 20% CF, ranging to 30% for those systems equipped with thermal storage.

Because of their intrinsic thermal collection-storage-delivery design, SGSPs can reliably deliver solar energy at a 95%+ duty cycle (“base-load”), or on-demand/peak and be combined with intermittent renewables for an “integrated base-load” delivery.

Typical 24 hour output of 1000 kW renewable systems
Comparison With Conventionals

Levelized Cost Comparison (w/o profit)

The projected SGSP levelized costs are competitive with conventional products:

- Including gas-fired plants in current cheap gas market
- Fully “Dispatchable”
- The range of levelized costs ($64-$75/MWh) represents early commercialization ($75) and anticipated high-volume production efficiencies ($64)
- Note the SGSP costs / values assume relatively “free” to low-cost salt (salt synergy)

### U.S. Average Levelized Costs (2010 $/megawatthour) for Plants Entering Service in 2017

<table>
<thead>
<tr>
<th>Capacity Factor</th>
<th>Levelized Capital Costs</th>
<th>Fixed O&amp;M</th>
<th>Variable O&amp;M (including fuel)</th>
<th>Transmission Investment</th>
<th>Total System Levelized Cost</th>
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<td><strong>Dispatchable Technologies</strong></td>
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Note: CCS = Carbon Control and Sequestration; ITC = Investment Tax Credit
Source: EIA [http://www.eia.gov/forecasts/aeo/electricity_generation.cfm](http://www.eia.gov/forecasts/aeo/electricity_generation.cfm) except for SGSP
Outline

GEM SGSP Proposal

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SGSP proposal for Truscott, Red River region

Status of the SGSP initiative
To reduce/control chlorides in regional water, the U.S. Army Corps of Engineers (USACE) collects saline river flow from the Wichita River with an inflatable weir dam and pumps it to the Truscott Lake for permanent impound. The system has been flowing an average of 200 tons/day dissolved salt to the reservoir since 1986 from one of three collection sites. Completing the other two collection sites would increase the salt capture to 500 tons/day, further reducing the salinity in Lake Kemp (water for Wichita Falls and Sheppard AFB), which currently requires desalination for use (irrigation, municipal). USACE has determined the Truscott dam will soon need refurbishment to mitigate diminishing freeboard; completing the other two sites would make this problem worse. 

Using the salt and lake bed for SGSP systems will negate the need to upgrade the lake dam while enabling salt collection from all three sites to facilitate full chloride control.
GEM Proposed SGSP Initiative

Project Starts With PPA

- Using the salt currently impounded in Truscott Lake, initially build 10-15 MW SGSP systems (at 5 MW per year)
- Tie-in to local power line, sell power
- 10-15 MW SGSPs will use most of the brine currently in the lake, using 750-1125 acres footprint (approx. half the area under water)
- Install the SGSPs within the lake bed area as the lake water is withdrawn for SGSP construction; optimize modularity
- Complete the other collection sites
- Flow 500 tons/day to the lake from all three sites and add 1 MW/year SGSP systems (75 acres per year)
- Truscott site large enough for 50 MW SGSP systems: a 35-40 year solution, or develop quicker per availability of salt

• Modular extensible
• Landscape conformable
• Tier-step to follow topo
GEM’s deployment of SGSP systems will provide a commercial solution to the region’s salt-contamination problem (Brazos & Red River Basins)

- USACE estimates 1.6M tons/year natural salt flows to the Red River Basin
- Studies estimate 2.4M tons/year natural salt flows to the Brazos River Basin
- GEM SGSP systems require approximately 170,000 tons/MW to build

- Regionally deploy SGSP systems to utilize the salt for profitable renewable power production
- Install ~24 MW per year (Red & Brazos River Basins) to match natural inflows, or faster if desired
- Use extraction wells to sequester the salt before it gets into the rivers for regional remediation
- Integrate with regional wind-energy to mitigate intermittent inefficiencies

- Add over 24 jobs/year to the region & over $140M capital development per year
Summary: Total Value Proposition as proposed to the USACE / USAF

1. **Offer a reasonable-to-competitive, long-term fixed power price**
   - Fixed price for Truscott power and ongoing SGSP development in TX, OK
   - Fixed price reduced by capital payment after systems paid off
   - USAF (and Army) benefits from all tech improvements (“cost plus” benefit)
   - Meet USAF (and Army) renewable objectives for TX (and elsewhere) affordably

2. **Achieve the USACE chloride control mission**
   - Profit-generating commercial transition, avoiding mounting costs
   - Total regional chloride control solution

3. **Greatly benefit the region**
   - Turn salt-contamination problem into economy generator: jobs for rural TX, OK
   - Agriculture, municipal/industrial water resources, health

4. **Help launch a game-changing renewable energy solution**
   - Wider use for the Services (CONUS & OCONUS) and for the U.S. at large
   - **AND all done in a low cost market / region, with all-in levelized costs**
Outline

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Status of the SGSP initiative
Truscott SGSP Project
Activities & Status

Key activities to date:

1. GEM meeting at USACE Tulsa District Office: 04 October 2011
2. GEM meeting at Red River Authority of TX (RRA): 03 November 2011
3. Execute GEM-RRA provisional letter of intent: 30 January 2012
4. **Red River Valley Association conference (Shreveport, LA): 23 February 2012**
5. USACE SW Division Commander Truscott site visit: 09 May 2012
6. GEM brief Energy Branch Chief, USACE CERL: 15 May 2012
7. RRA/USACE/RRVA Steering Committee meetings: April 9 & June 5, 2012
8. Table Top Exercise with USACE, RRA, RRVA and GEM (decide on easement process): 09-11 July 2012
9. GEM-RRA Initial Agreement signed: 18 July 2012
10. Assistant Secretary of the Air Force briefed on Truscott by Sheppard AFB: 20 July 2012
12. Ass. Sec. of the Army briefed by USACE Dallas /Tulsa: July 2012
13. GEM brief AETC at Randolph AFB (responsible for power purchase at Sheppard AFB): 02 August 2012
14. RRA application submitted to the USACE for Truscott easement: August 2012
15. GEM brief the Army EITF, NREL, USACE, and CERL on SGSP technology and Truscott: Aug & Nov 2012
16. USACE/USAF/EITF conduct a series of multi-agency mtgs to review the SGSP project: Sept.12-Jan.13
18. **Red River Valley Association conference (Shreveport, LA): 21 February 2013**

Status:

- Working to find customer for the Truscott power (1st 5MW): 25 year, fixed-rate contract
  - *Must have power agreement before going forward*, issue: long-term contract in today’s pwr market