Good Earth Mechanics

19 March 2013

Subject: Submitted Comment to the CEC's "RENEWABLES PORTFOLIO STANDARD ELIGIBILITY Seventh Edition Staff Draft Guidebook"

Reference: "Advancements in Salinity Gradient Solar Pond Technology Based on 16 Years of Operational Experience"; Huanmin Lu, Andrew H. P. Swift, Herbert D. Hein, Jr., John C. Walton; J. Solar Energy Eng., v.126, p. 759-767, May 2004
http://www.goodearthmechanics.com/pdfs/JSEE%20Paper%20Lu%20SP.pdf

Comments:

We are seeking clarification that Salinity Gradient Solar Pond (SGSP) technology will be included as an applicable renewable energy resource in the subject document. Specifically in section "II. Energy Resource Eligibility Requirements" under "J.2. Solar Thermal", as worded below, we are asking clarification that SGSP technology be included as "Solar Thermal". If the CEC believes there is any ambiguity, we would ask that the additional words in brackets [] be included.

Solar Thermal

Solar thermal electric facilities use solar radiation to create a thermal potential, typically in a fluid. ***[This category includes Salinity Gradient Solar Pond technology.]*** *Many solar thermal electric facilities incorporate supplemental boilers or some form of thermal energy storage. Solar thermal electric facilities that include a supplemental boiler to add thermal energy to the working fluid for any purpose are subject to the requirements of Section III.B: Renewable Facilities Using Multiple Energy Resources. Solar thermal electric facilities with thermal storage incorporated into the generating process are eligible consistent with Section III.G: Energy Storage*

For information, an overview of SGSP technology is provided below and the referenced paper above summarizes our team's 16 years' experience developing SGSP technology at the University of Texas El Paso. We envision that SGSP technology will be extremely important in California's renewable energy architecture going forward.

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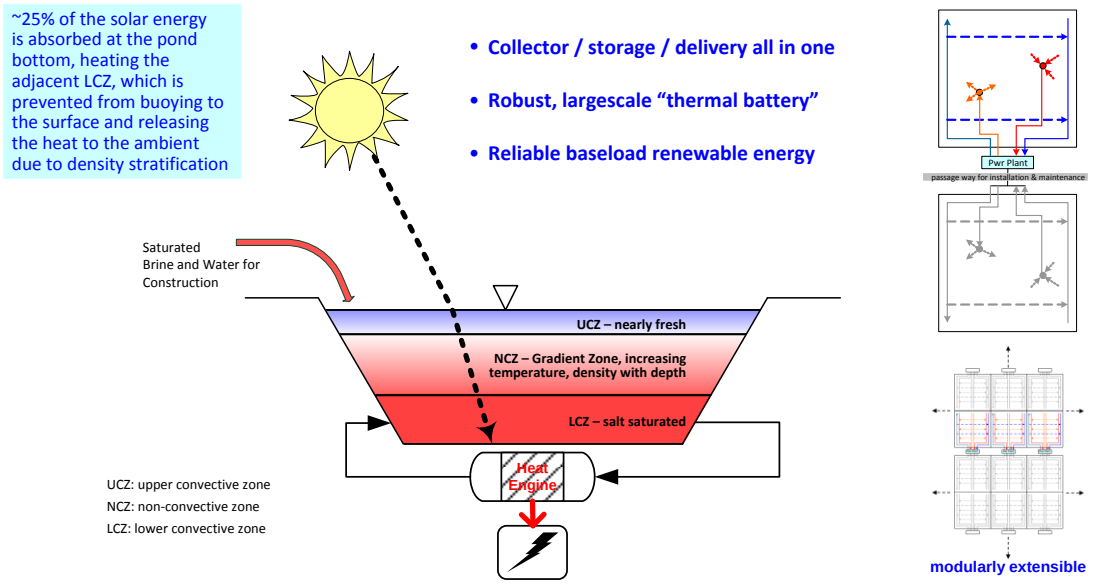
Overview of SGSP Technology

A Salinity Gradient Solar Pond (SGSP) is a shallow, salt-gradient pond that enables the collection and storage of solar thermal energy (see figure below). Solar thermal energy is collected and stored in the bottom layer of the pond system. This energy is withdrawn (pumped hot brine) as process heat which can be used to generate electricity using an off the shelf, low-temperature heat engine. The SGSP can collect and store heat, and deliver power at an average, uniform rate (base-load), or can deliver power on an as needed basis (on-demand) giving distribution control of the power output rather than being forced to produce power solely when the wind blows or the sun shines, making SGSP systems many times more effective than intermittent renewables. The GEM SGSP systems can be easily constructed over large areas. GEM builds the systems in 250 kW modules, using two pond units for each module (typically 6 acres per pond unit). The ponds are bermed impoundments versus excavated holes, where the dirt from the pond centers is used to form the berms. The GEM SGSP systems are modularly extensible: the SGSP site can be as small as 250 kW, or scaled up to 100's of MW's, by simply adding more SGSP modules. SGSP systems require a lot of salt for construction: 130,000 – 200,000 tons per base-load MW.

The GEM SGSP team also operated the longest running SGSP engineering development and pilot demonstration in the world to date (University of Texas, El Paso). The SGSP team's actual experience operating SGSP systems led to the development of unique operations and maintenance solutions for the challenges that the development testing and operation brought to light. The knowledge gained from those operations make the GEM SGSP team the leading experts in the world for the design and operation of these game-changing solar energy systems.

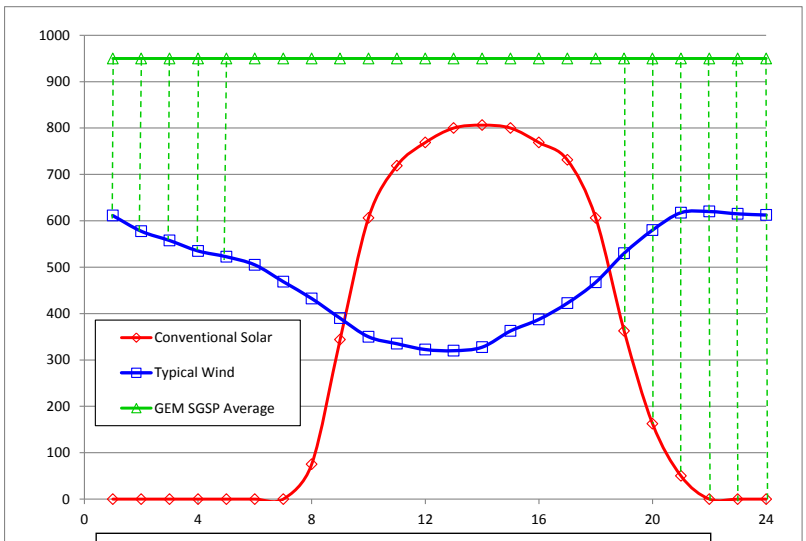


The table below compares SGSP systems with other power technologies in terms of levelized costs (total costs on a unit basis of delivered energy). GEM SGSP systems are shown to be very competitive with conventional power products, including gas-fired plants, and several times cheaper than the other renewables; and SGSP technology is the only renewable energy system (besides biomass and geothermal) capable of delivering base-load or on-demand power ("dispatchable"). The range of levelized costs ($64/MWh – $75/MWh) represents early commercialization ($75) and anticipated cost reductions for mature commercialization ($64), e.g., allowing for economies of scale and production efficiencies. Note the SGSP levelized costs are predicated on a relatively inexpensive salt source, e.g., waste or surplus salt.

U.S. Average Levelized Costs (2010 $/megawatt hour) for Plants Entering Service in 2017						
	Capacity Factor	Levelized Capital Costs	Fixed O&M	Variable O&M (including fuel)	Transmission Investment	Total System Levelized Cost
Dispatchable Technologies						
Conventional Coal	85	64.9	4.0	27.5	1.2	97.7
Advanced Coal	85	74.1	6.6	29.1	1.2	96.1 (ITC: -14.8)
Advanced Coal CCS	85	91.8	9.3	36.4	1.2	138.8
Natural Gas-fired						
Conv. Comb. Cycle	87	17.2	1.9	45.8	1.2	66.1
Adv. Comb. Cycle	87	17.5	1.9	42.4	1.2	63.1
Advanced CC + CCS	87	34.3	4.0	50.6	1.2	90.1
Conv. Comb. Turb.	30	45.3	2.7	76.4	3.6	127.9
Adv. Comb. Turb.	30	31.0	2.6	64.7	3.6	101.8
Advanced Nuclear	90	87.5	11.3	11.6	1.1	111.4
Geothermal	91	75.1	11.9	9.6	1.5	90.7 (ITC: -7.5)
Biomass	83	56.0	13.8	44.3	1.3	115.4
SGSP	**95**	**60 50**	**25 20**	**0**	**5**	**75 (ITC: -15) 64 (ITC: -11)**
Non-Dispatchable Technologies						
Wind	33	82.5	9.8	0.0	3.8	96.0
Solar PV1	25	140.7	7.7	0.0	4.3	138.6 (ITC: -14.1)
Solar Thermal	20	195.6	40.1	0.0	6.3	222.4 (ITC: -19.6)
Hydro2	53	76.9	4.0	6.0	2.1	88.9

Note: CCS = Carbon Control and Sequestration; ITC = Investment Tax Credit
Source: EIA http://www.eia.gov/forecasts/aeo/electricity_generation.cfm except for SGSP

The solar pond systems can be configured to deliver power on-demand, counter-cycle to the existing intermittents as notionalized in the figure below. A wind system, as indicated in blue, typically delivers power in the night and droops during the heat of the day, where the typical PV system, shown in red, delivers power during the day and nothing at night. The SGSP systems can be configured to back-fill these undersupplied gaps, producing an integrated base-load, or deliver to some other specific load demand curve. Currently this back-fill function is typically done with gas-fired back-up plants, at nearly twice the cost of full-duty gas power (see chart above, compare 87% CF gas power with 30% CF gas power). Solar ponds can provide this back-fill function at a cost savings to conventional gas, and offer a fixed power price (e.g., fuel constant). And also this would be a truly total renewable energy power delivery.



Typical 24 hour output of 1000 kW renewable systems