Torresol Energy
reinventing solar power

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May 9, 2011

Chairman Bob Weisenmiller
Commissioner Karen Douglas
California Energy Commission Docket Office, MS-4
1516 Ninth Street
Sacramento, CA 95814-5512
docket@energy.state.ca.us

Re: California Energy Commission Docket No. 11-IEP-1N: Comments Related to Energy Storage for Renewable Integration

Chairman Weisenmiller and Commissioner Douglas:

Thank you for holding workshops on the issue of energy storage and renewable integration as well as the opportunity to provide comments to you on this timely topic. As a solar technology and project development company, we understand the concerns regarding the integration of some renewable generation into the state's electricity system. Solar and wind generation in particular have significant climate, air quality, and energy independence benefits. The intermittent nature of these technologies, however, will preclude their extensive development unless some type of storage is incorporated into the electricity system. This is an issue that Torresol Energy and SENER Engineering and Systems, our sister company, have addressed proactively in the design, construction, and operation of our solar trough and solar tower project designs. As a result, competitive, bankable, and fully dispatchable solar power plants are currently available on a commercial scale.

Integrated Renewable and Storage Projects

As background, Torresol Energy and SENER have developed a number of natural gas combined cycle, waste to energy, and biomass power plants in Europe. They have also been involved in the design and construction of 17 solar power units in different parts of the world and two in the United States. More importantly for this proceeding, 12 of the units include fully integrated thermal energy storage systems, with capacities ranging from 7.5 to 15.0 hrs. Among them, the 100 MW Andasol plant, operating commercially in Spain since early 2008, was the first commercial utility scale unit in the world operating with thermal energy storage. The plant is fully dispatchable, as certified by REE, the Spanish National System Operator.

Torresol Energy and SENER have developed and are also constructing the Valle 1 and 2 power plants in Spain which, when operational in 2011, will produce together 100 MW of dispatchable power using solar trough coupled with molten salt storage. This integrated solar collection, thermal storage, and electricity generation project will be located on approximately 988 acres.

Torresol Energy and SENER have also developed an integrated solar power tower and thermal storage technology. The SENERTower uses molten salt in its receiver and thermal storage system to deliver up to 15 hours of electrical generation without incoming solar radiation. This technology, as well as the SENERTrough coupled with thermal storage,

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eliminates the spikes common to some solar technologies and allows for continuous load following capability. The Gemasolar power plant, equivalent to a 50 MW power plant without storage, is the first commercial tower power plant with storage. It went into commercial operation last month in Spain. It uses a 400 foot tower on a 355 acre site.

The system and equipment benefits of integrated solar collection, thermal storage, and electricity generation projects include:

- Full dispatchability – including generation after sunset.
- Increased number of hours of operation resulting in better utilization of the plant investment, lowering the LCOE (this is especially important if the size of the steam turbine is limited for any reason).
- Ability to move energy generation to peak hours and respond to time of day usage variation.
- Elimination of sun radiation transients - a sudden drop in radiation reduces heat flow to storage but not to the turbine.
- Easier turbine start-up – excess heat output from the field is directed to storage and not wasted if the turbine start-up is slower than the solar field start-up.
- Easier turbine start-up: with storage, the turbine shut-down period at night is far shorter and the turbine is warmer in the morning.
- Ability to match baseload operations - the turbine may not need to be shut down for months.
- Longer turbine and other equipment life due to the fewer and softer transients.
- Improved utilization of transmission system infrastructures (lines, substations).
- Ability to use a smaller turbine size to generate the same amount of annual energy. An example is the Gemasolar power plant which is rated at 17 MW but generates with storage the same amount as a 50 MW facility.
- Lower potential for network instability problems - in case of a turbine trip, the effect in the network is lower with a smaller machine.

Both the SENERTrough and SENERTower projects using thermal storage can be developed using minimal roads, retention of significant on-site vegetation, minimal water use for steam turbine make-up water and mirror washing, and dry cooling. SENERTower can also be developed using minimal on-site grading. The technologies use a modular design allowing projects using the SENERTrough with storage to range from 50 MW to over 1,000 MW. The SENERTower can be scaled down to 10 MW with a 200 foot tower located on a 90 acre site to projects larger than 1,000 MW.

During the April 28, 2011 workshop, the presentation by Dan Rastler of the Electric Power Research Institute pointed out the relative energy duration, efficiency, and cost of various commercial and demonstration storage technologies. His supporting documentation, EPRI Research Report 1020676, also provides capacity and power information on these technologies. As shown on the following table, the capability and cost of the thermal storage coupled with the SENERTrough and SENERTower is superior to these technologies.

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Comparison of Commercial Energy Storage Options to support Large Renewable Integration

Technology	Capacity (MWh)	Power (MW)	Duration (hrs)	% Efficiency	Total Cost ($/kW)	Cost of Storage ($/kWh)
Pumped Hydro 1/	1,680 – 5,300	280 - 530	10 - 20	80 - 82	1,500 – 4,300	250 - 430
Compressed Air 1/	1,080 – 2,700	135	10 - 20		960 – 1,250	60 - 125
Sodium-Sulfur 1/	300	50	6	80	3,200 – 4,200	445 - 555
Advanced Lead-Acid 1/	200 - 250	20 - 50	4	85 - 90	2,020 – 3,040	505 - 760
Molten Salt with SENER Trough	1,000 – 6,000	50 - 300	3 - 8	95	N/A 2/	60 - 100
Molten Salt with SENER Tower	1,000 – 6,000	20 - 200	3 - 18	99	N/A 2/	40 - 60

1/ Sources: Presentation by Dan Rastler to the California Energy Commission, April 28, 2011; EPRI, Electricity Energy Storage Technology Options, 1020676, page 4-22
2/ Depends on the number of hours of storage incorporated.

Barriers to Energy Storage

One focus of the April 28 workshop was to identify and discuss barriers associated with the successful development and deployment of energy storage projects particularly in relationship to meeting California's Renewable Portfolio Standard. From our perspective, one solution to this concern has been developed and demonstrated at a commercial scale in our Gemasolar plant. The barriers associated with deployment of integrated solar collection, storage, and power generation facilities are the following:

1. **Lack of market incentives for dispatchable renewable energy.** Currently the utilities evaluate renewable projects during the procurement process based solely or primarily on price of energy delivered. They do not or are not allowed to provide any adder or other incentive for dispatchability and stability of the electric supply. The result is a disincentive to building integrated renewable/storage projects because of the increased cost of the storage component even though this is more efficient and cost effective than developing stand-alone storage projects and has other substantial system benefits.

2. **Lack of transmission interconnection incentives for dispatchable renewable energy.** Although the California Independent System Operator expressed concern at the workshop about the challenges of integrating renewables into the electricity grid due to extreme variability, transient power issues, and lack of ability to follow load, we are not aware that the CAISO transmission interconnection provides any incentive

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to develop renewable projects that avoid these concerns. The cost, reporting, and scheduling challenges in working with the CAISO and utilities are the same regardless of the system benefits projects provide.

3. **Lack of permitting incentives for dispatchable renewable energy.** In a separate proceeding, developers have identified some of the barriers and challenges associated with developing renewable energy projects in California. The current permitting processes, in some ways, are out of sync with the policy directives to develop renewable projects. This concern extends to integrated renewable/storage projects. These projects do require more land than projects without storage but it is unclear whether either system benefits or the avoided impacts of stand-alone projects will be considered in the permitting process.

Although the SENERTrough and SENERTower technologies coupled with molten salt storage are available to generate dispatchable solar power, efforts are needed to continue to improve the amount of storage, efficiency of the process and reduce the cost. An article in CPS Today[1] discussed ongoing research by SENER, the University of California at Berkeley and GrafTech International funded by the U.S. Department of Energy to develop a higher efficiency storage system for solar power plants. This and similar research should also be supported by the Energy Commission's PIER program as well as utility R&D funds. Currently these programs appear focused on stand-alone storage systems rather than storage systems that are directly coupled with the facility that produces the renewable power.

Recommended Actions

Our recommendations mirror what we consider barriers to the development and deployment of integrated renewable/storage projects:

1. **As part of its direction to the utilities on renewable procurement, the CPUC should establish an adder or other incentive for dispatchable renewable energy. The adder or other incentive should be proportional to the demonstrated degree of dispatchability.**

2. **The CAISO should provide an incentive for dispatchable renewable energy in its transmission interconnection process.**

3. **The CEC should establish a policy to specifically consider the benefits and avoided impacts of dispatchable renewable energy in power plant siting cases.**

[1] Article available at: http://social.csptoday.com/industry-insight/graphite-thermal-storage-coming-soon-csp-project-near-you?utm_source=http%3a%2f%2fcommunicator.csptoday.com%2flz%2f&utm_medium=email&utm_campaign=CSP+eBrief+3+May+11&utm_term=CSP+plant+modelling%3a+Pinpointing+output+and+revenue+forecasts&utm_content=605189

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4. **The CEC should include the funding of integrated renewable/storage research, development, and demonstration projects in its energy research and development programs.**

Thank you again for your bringing energy storage into the discussion of solutions for integrating renewables into the electricity system and exploring various actions to enhance development and deployment of this critical technology. Thank you also for your consideration of our comments and recommendations.

Sincerely,

Felicia L. Bellows
Senior Vice President of Development