Proposed Agreement between California Energy Commission and Combined Power Cooperative

Title: Hyperlight Ultra Low-Cost, Dual Purpose, Concentrating Linear Fresnel Reflector/Heat Exchanger
Amount: $1,000,000.00
Term: 45 months
Contact: John Mathias
Committee Meeting: 3/16/2011

Funding

FY	Program	Area	Initiative	Budget	This Project	Remaining Balance	
09	Electric	EA	Aquatic Resources	$1,500,000	$698,818	$0	0%
09	Electric	EA	Global Climate Change	$4,323,000	$301,182	$0	0%

Recommendation

Approve this agreement with The Advanced Lab Group Cooperative for $1,000,000.00. Staff recommends placing this item on the discussion agenda of the Commission Business Meeting.

Issue

According to Governor Jerry Brown's new energy plan, by 2020, California should produce 20,000 new megawatts (MW) of renewable electricity. Furthermore the Governor calls for the Legislature to codify a requirement that 33% of the state's electricity be derived from renewable sources. This step will build upon Governor Arnold Schwarzenegger's Executive Order S-14-08 that directed state government agencies to take all appropriate actions to help achieve California's Renewable Portfolio Standard (RPS) goal, which requires retail sellers of electricity to serve 33 percent of their load with renewable energy by 2020.

Also in Governor Brown's energy plan is building 12,000 megawatts of Localized Electricity Generation; 8,000 Megawatts of Large Scale Renewables; and increasing combined heat and power production by 6,500 megawatts. Localized energy is onsite or small energy systems located close to where energy is consumed that can be constructed quickly (without new transmission lines) and typically with relatively low environmental impact. Combined heat and power projects (also known as cogeneration) use the excess heat or electricity generated by power plants or industrial facilities and are much more efficient than traditional power plants and many industrial plants.
Solar development and particularly utility scale solar development is a crucial part of achieving these various goals in Governor Brown's energy plan. The California Public Utilities Commission (CPUC) suggests that the technology mix, for the baseline scenario to reach 33 percent by 2020, will primarily rely on wind, solar thermal, geothermal, solar photovoltaics (PV) (at generation of 44 percent, 24 percent, 15 percent, 9 percent respectively) and the rest from low levels of biomass, biogas and small hydro (generation of 4 percent, 3 percent and <1 percent respectively).

While utility scale solar development will play an important role in achieving the State's RPS target, such development has large land and water requirements, and can have negative impacts on delicate ecosystems and vulnerable species, particularly in the desert. There is a need for new solar technologies that enable a lower impact for solar development through reducing land demand or water demand per unit generation relative to current technologies. This technology would use about 4 acres per MW vs 7-8 for other technologies.

Background

In response to EO S-14-08, and concern about the impact of renewable development in the California desert regions as reflected by the DRECP, the PIER Energy-Related Environmental Program, in conjunction with PIER Renewables, released a request for proposals (RFP) for RD&D aimed at innovative utility-scale solar energy technologies, spatial arrays, and methods of installation/maintenance that result in significantly lowered facility footprint and/or land impact, as well as innovative approaches to reduce the major freshwater consuming aspects of utility-scale solar energy. The proposals were asked to address one or more of the following technical objectives:

- Technology solutions or approaches that will support greater solar energy penetration in the California electricity grid by reducing project specific demands on land and fresh water, such as more efficient technologies that reduce land footprint per unit solar generation.
- Innovative technologies or approaches that significantly reduce negative impacts on sensitive species and/or ecosystems for a given amount of solar generation and/or significantly improve the sustainable co-existence of the solar plant and the surrounding wildlife and environment compared to current solar technologies or approaches.
- Technologies that can better utilize areas of sub-optimal solar resources, and/or be installed on a wider or different range of slope and terrain than current solar technologies, and/or have greater flexibility in plant configuration and footprint shape, therefore expanding site selection options and opportunity for avoidance of sensitive or undisturbed habitats and increased utilization of disturbed or developed land for utility-scale solar.
- Alternative site preparation treatments with significantly reduced impacts on biological resources (for example, alternative site layouts, installation techniques that reduce grading).
- Innovative methods to mitigate the cost and performance penalties associated with the use of air cooled condensers or hybrid cooling technologies for power plant cooling (steam condensation) at solar thermal power plant projects.

Funding of $1 million was allocated to proposals received in this effort. A total of 3 proposals were received, and two were awarded. The scoring committee consisted of staff from the PIER Environmental and Renewable Programs.

Proposed Work

The overall goal of the project is to develop and demonstrate the Advanced Lab Group's "Hyperlight" concentrated solar thermal power technology. The Advanced Lab Group's innovation is a unique, low cost, reflector system for a Compact Linear Fresnel Reflector (CLFR), which simultaneously serves as a heat exchanger that enables non-evaporative cooling of the power generator block. The technology has the potential to achieve the technical objectives for the RFP by enabling a utility scale solar technology with reduced demands on land and fresh water, as well as greater flexibility in plant configuration and footprint shape, expanding site selection options and opportunity for avoidance of sensitive or undisturbed habitats and increased utilization of disturbed or developed land.

Key to the Hyperlight technology achieving these objectives is the use of disruptively low cost materials and fabrication techniques for the reflector system, while at the same time maintaining acceptable efficiency in the concentration of solar energy. The most important cost driver of a CLFR plant is the solar reflector field, accounting for up to 45 percent of the total power plant cost. Currently, utility scale concentrating solar power (CSP) uses large amounts of relatively expensive glass and steel as primary construction materials. In contrast the Hyperlight reflector field is made of transparent plastic tubes, with a metalized polymer reflective facet mounted inside, that reflects incident sunlight onto a heat

collecting element centered above the array of tubes. Instead of metal being used for the structural support of the solar reflectors, the plastic tubes are floated on water (with a water ballast). Evaporation of the water used to float the reflector containing tubes is greatly reduced by the tight spacing of the tubes on the water surface - which is another key aspect of this technology.
A high level summary of the Hyperlight concentrated solar thermal power technology is as follows: the array of novel Hyperlight reflectors concentrate incident solar energy on a heat collection element in a CFLR setup where steam is generated in a pipe within the heat collection element, and directed to a turbine for power generation. After generating power the steam is cooled in a condenser using cooling water drawn from the water-filled basin that the hyperlight tubular reflectors float in. The heated water from the condenser is then returned to the basin, however instead of the basin being cooled by evaporation, as in a regular cooling pond, evaporation is prevented by the floating hyperlight tubes, and the basin is instead cooled by convection from air blown through the floating hyperlight tubes.
The specific objectives of the project are to:
1) Increase the geometric concentration ratio (the ratio of a solar collector aperture area to the absorber area) achieved with the Hyperlight reflector system from its current value of 17x to 70x
2) Improve the annual average thermal efficiency of the system from its current approximate value of 17% to 30%
3) Improve evaporative loss performance of the cooling system from its current value of more than70% below open pond evaporation rate to more than 90% below open pond evaporation rate
4) Validate existing dry cooling models for their system to within 25% for kWh heat removed per kWh of air blower power used
These results will be used to build and demonstrate an environmentally sound, economically-feasible power generation system with advanced dry-cooling capability. In this capacity, two of the project collaborators will be an industrial customer that has agreed to provide a site for the project, namely key partner Imperial Valley Cheese, and an engineering, procurement and construction firm, Burns and McDonnell. The project site will be located in El Centro, California.
Subcontractors in the project are the University of California Santa Barbara, and Cal Poly San Luis Obispo (Cal Poly SLO). UCSB and Cal Poly SLO will focus on investigating and analyzing, both experimentally and using modeling, the dry cooling performance for the floating tube heat exchanger in the Hyperlight CLFR system.
The overall program cost will be $1,514,965, of which $1,000,000 will be PIER funds and $514,965 matching funds in the form of cash and in kind contributions from ALG and partners, and cash from university research partners UCSB, and Cal Poly SLO.

Justification and Goals

This project "[will] advance energy science or technologies of value to California citizens..." (Public Resources Code 25620.(c)), and is part of a "full range of research, development, and demonstration activities that . . . are not adequately provided for by competitive and regulated markets (Public Resources Code 25620.1.(a)).

The proposed work meets the objectives of the RFP for Environmental Mitigation for Utility-Scale Solar Energy Technologies (500-10-503), which was designed to address EO S-14-08 and the DRECP, and which is in line with Governor Brown's new energy plan. It meets the objectives by performing R&D on a technology that could produce more power than current CSP systems for a given amount of land, with greater flexibility in plant configuration and footprint shape, and greater applicability to areas of sub-optimal solar resources.
The greater power per footprint area is a result of design considerations that follow from the Hyperlight's low cost reflectors. The low cost allows the reflectors to be spaced very closely together compared to current CLFR configurations, which space their reflectors out in order to avoid shading of

some reflectors by other reflectors at times during the day. The close-packed layout proposed by ALG leads to more shading per reflector at times during the day, however it is calculated that the self-shading effect is not large enough to outweigh the increased number of reflectors in a given space, resulting in a net increased average power generation per unit of land compared to current state-of-the-art CSP.
The low cost reflectors also enable the Hyperlight technology to be sited on relatively small or irregular plot sizes by providing a low Minimum Economic Scale (MES) for the facility; calculated to be only 16 hectares (40 acres) â€" lower than traditional CSP technologies. Because of the low MES, it can be economically deployed on smaller plots which can increase the opportunities for utilizing previously developed or disturbed land for solar development and using alternative site layouts configured to avoid sensitive biological resources. The low cost reflectors are also calculated to lower the direct normal insolation (DNI) required for an economically viable project from a bottom threshold average DNI of 5.2 kWh/m2/day, to below 5 kWh/m2/day, further increasing opportunities for the use of previously developed or disturbed land. The levelized cost of electricity over 30 years using Hyperlight technology is $0.08/kWh with current component prices and is projected to be $0.04/kWh in 2020.
The project can help address the renewable electricity, localized electricity generation, and combined heat and power goals in Governor Jerry Brown's new energy plan, as well as EO S-14-08 and 2009 Integrated Energy Policy Report, while also helping support the conservation goals of the Desert Renewable Energy Conservation Plan.

This will be accomplished by:

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