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High Altitude Solar Research Concept Proposal

Additional submitted attachment is included below.

CALIFORNIA ENERGY COMMISSION

ELECTRIC PROGRAM INVESTMENT CHARGE 2021-2025 (EPIC 4)
RESEARCH CONCEPT PROPOSAL FORM

The CEC is currently soliciting research concept ideas and other stakeholder input for the EPIC 4 Investment Plan. For those who would like to submit an idea for consideration, we ask that you complete this form and submit it to the CEC by 5:00 p.m. on **July 2, 2021**.

To submit the form, please visit the e-commenting link, https://efiling.energy.ca.gov/Ecomment/Ecomment.aspx?docketnumber=20-EPIC-01, enter your contact information, and then use the "choose file" button at the bottom of the page to upload and submit the completed form. Thank you for your input.

1. Please provide the name, email, and phone number of the best person to contact should the CEC have additional questions regarding the research concept:

   Andrew Popell
   andy@stratosolar.com
   415-457-3969

2. Please provide the name of the contact person's organization or affiliation:

   Stratosolar, Inc.

3. Please provide a brief description of the proposed concept you would like the CEC to consider as part of the EPIC 4 Investment Plan. What is the purpose of the concept, and what would it seek to do?

   We propose doing research on the increased efficiency of solar panels at high altitudes. Because sunlight is not absorbed or scattered by the thin atmosphere in the stratosphere and is available 100% of the time during daylight hours (as there is no rain, hail, snow, clouds or moisture) and temperatures are very low, solar panels should be an order of magnitude more efficient than panels on the ground.

   Our purpose is to prove that PV panels on high altitude platforms are 2 to 4 times more efficient in generating electricity than those on the ground and do not suffer from daylight intermittency.

   We seek to design and build photovoltaic systems (solar farms) on very large buoyant platforms suspended at 65,000 feet using existing proven technology.

4. In accordance with Senate Bill 96, please describe how the proposed concept will **"lead to technological advancement and breakthroughs to overcome barriers that prevent the achievement of the state's statutory energy goals."** For example, what technical and/or market barriers or customer pain points would the proposed concept address that would lead to increased adoption of clean energy technologies? Where possible, please provide specific cost and performance targets that need to be met for increased industry and consumer acceptance. For scientific analysis and tools, what data and information gaps would the proposed concept help fill, what specific stakeholders will use the results, and for what purpose(s)?

According to the CEC, to meet California's 2045 retail electricity zero-carbon targets, 57 GW of new solar utility scale electricity needs to come online. The CEC has identified scalability (build rates would need to triple to achieve these goals) and land use challenges as significant barriers. Higher electricity prices are also a significant customer pain point. High prices become even more of a problem as California approaches its zero-carbon goal because mitigating solar intermittency will require large costly excess PV capacity, storage and long-distance transmission.

High altitude solar farms that are 2-4 times as efficient as those on the ground and do not need large costly excess PV capacity, storage and long-distance transmission would allow manufacturers of solar farms to overcome these barriers and help California achieve its 2045 goals.

Land use would be 1% of a comparable solar farm on the ground. The cost of intermittent electricity (without storage) would be 33% of electricity produced by a ground based solar farm and with nighttime storage would be 10% the cost for on-demand ground based PV electricity.

5. Please describe the anticipated outcomes if this research concept is successful, either fully or partially. For example, to what extent would the research reduce technology costs and/or increase performance to improve the overall value proposition of the technology? What is the potential of the technology at scale?

We anticipate that solar panels in the stratosphere will be 2-4 times as efficient as solar panels on the ground. Price of electricity would be 33% of that on the ground. Solar farms in the stratosphere could provide scalable electricity in utility scale systems from 10 MWp to 1 GWp in 10MWp modular increments.

6. Describe what quantitative or qualitative metrics or indicators would be used to evaluate the impacts of the proposed research concept.

The main metric we would evaluate is a comparison of solar power output (Watts produced/ square foot) of solar panels at altitude vs. on the ground at the same longitude/latitude and time of day.

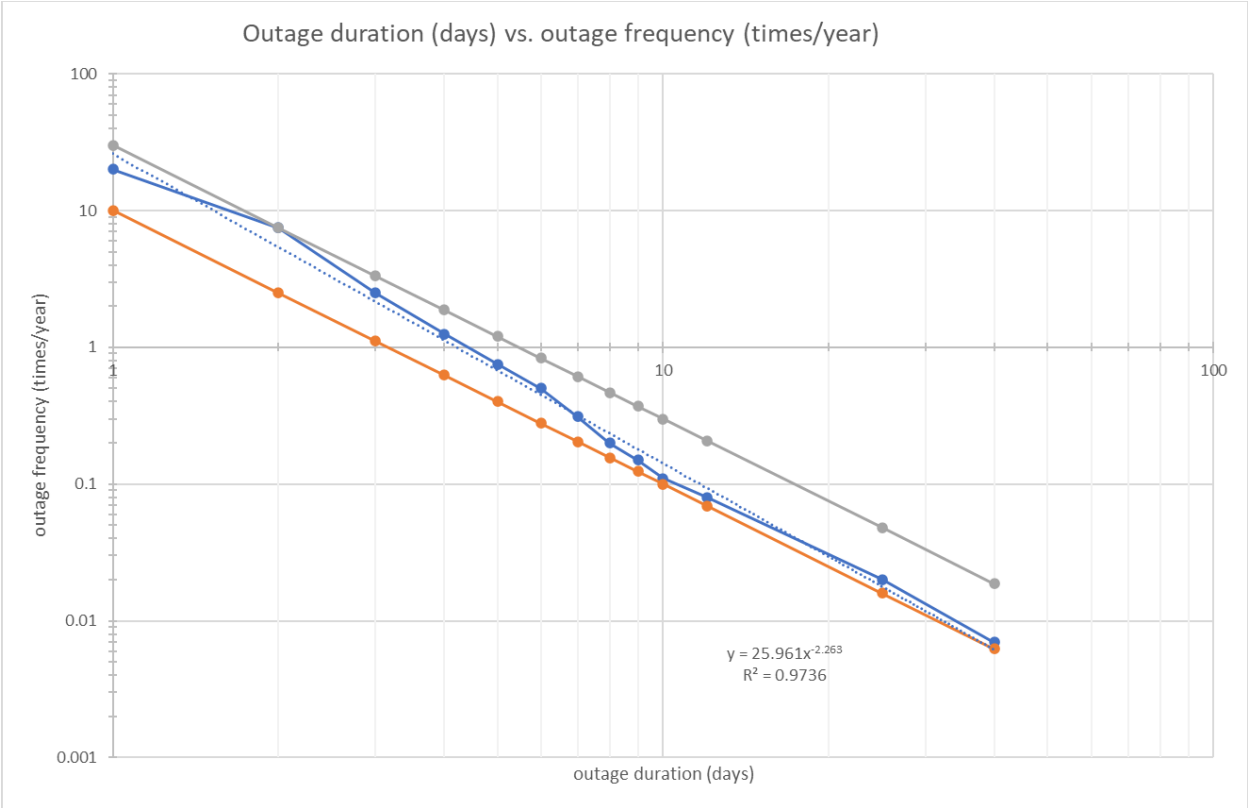
7. Please provide references to any information provided in the form that support the research concept's merits. This can include references to cost targets, technical potential, market barriers, etc.

Land use issues:
https://e360.yale.edu/features/its_green_against_green_in_mojave_desert_solar_battle
https://www.theguardian.com/sustainable-business/solar-power-parks-impact-environment-soil-plants-climate

Temperature effects on solar panel efficiency:
http://www.scienceline.ucsb.edu/images/solarTempDepend
https://www.solar.com/learn/do-solar-panels-work-less-efficiently-at-certain-temperatures/

Increase in renewable energy effect on electricity prices:
https://www.congress.gov/116/meeting/house/111070/witnesses/HHRG-116-IF03-Wstate-BryceR-20201001.pdf
https://environmentalprogress.org/big-news/2018/2/12/electricity-prices-rose-three-times-more-in-california-than-in-rest-of-us-in-2017

Weather in the stratosphere:
https://www.weatheronline.co.uk/reports/wxfacts/Stratosphere.htm
https://study.com/academy/answer/what-weather-occurs-in-the-stratosphere.html



This graph shows a range between the orange and grey lines of outage frequencies against outage durations for different geographies. Each geography will have its own unique statistics. An outage is defined as when supply is less than 50% of demand. The blue line represents California, mostly winter storms. The dotted line is a power curve trend line for California which has an exponent of -2.263, almost an inverse square law. This seems to be a general characteristic of the planets weather system.

The way to understand the left axis of outage frequency is numbers greater than one are outages per year while numbers less than one are years per outage. .1 is every 10 years, .01 is every 100 years. California has a four-day outage about once a year, a ten-day outage about every 10 years, a thirty-day outage about every 100 years.