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California Energy Commission
Dockets Office, MS-4
Docket No. 09-RENEW EO-01
1516 Ninth Street
Sacramento, CA 95814-5512
Fax: 916-654-4421

Re: Comment on the DRECP

I am a professor of ecology and evolutionary biology at the University of California, Santa Cruz, and Director of the Institute for Ecological and Evolutionary Climate Impacts, a UC System-wide Research Consortium and Climate Impacts Observatory Across the UC Natural Reserve System. I am writing to express my concerns about Solar Development Projects outlined in the DRECP. The EIR/EIS available for the DRECP do not critically address the long-term impacts on Desert Tortoise, *Gopherus agassizii*. I request that this letter be included in the Public Record for the DRECP.

At three recent professional meetings, I presented papers (published abstracts attached below) detailing the results of my recent research on the impacts of climate change on the gopher tortoises, and in particular on the desert tortoise. The paper abstract – presented at the 2014 Desert Tortoise Council Symposium in Ontario, California, 2014 – details the threats of solar development on the Desert Tortoise, *Gopherus agassizii*. A similar talk was presented at the North American Congress for Conservation Biology (NACCB) in July 2014 in Missoula, Montana, and at the NACCB meetings in July 2012 in Oakland, CA. I will also be giving a talk to the BLM, Riverside, CA, on February 28, 2015 on the impacts of solar developments for Mojave Desert ecosystem.

My research demonstrates that, in light of increasing temperatures and drought conditions, due to ongoing climate change, many desert tortoise populations will go extinct in the next several decades. The research further shows that a few key sites such as the Ivanpah Valley will continue to be a refugium for the desert tortoise as the effects of climate change progress and render many of its habitats unsuitable for this threatened species. Indeed, the research concludes that the Ivanpah Valley and the habitat near California City, California, are the *only* habitats predicted to sustain population demography in the long-term. New research also demonstrates that these risks are also exacerbated by the increased incidence of mortality as tortoise cross roads, which are developed around new solar farms.

Solar projects developed in the Ivanpah Valley and near California City pose a serious risk to the two key refugia for the desert tortoise. To the contrary, it is my professional opinion that given the construction of these projects, there is a substantial risk that they will jeopardize the continued existence of the species, which in turn jeopardizes the continued existence of the species overall.

This is true for several reasons. First, the projects will remove thousands of additional acres of usable habitat for desert tortoises. This includes not only the large footprints of the projects themselves, but the serious Urban Heat Island Effect that these solar panels cause, extending the area of unusable habitat well beyond the borders of the project. Moreover, any solar development generates infrastructure (transmission lines) that attracts the development of new solar projects. As the solar projects grow in size the magnitude of the Urban Heat Island Effect caused by the solar panels grows in magnitude.

In sum, as our paper sets forth in great detail, while solar projects may be intended to help *address* the harmful effects of climate change, we can expect solar projects in designated Solar Development Zones to accelerate the predicted extinctions of the species by 50 years. These research papers raise significant environmental issues including those that address the following:

- Issues requiring clarification or modification of an alternative plan in the siting of solar projects,

- Issues requiring development of an alternative strategy that was not previously given serious consideration given that the science does not accurately address the interaction of ongoing climate change with the continued development of solar projects,
- These issues would lead to a revised or supplemental EIS/EIR, were the data available to the DRECP processes.

Synopsis of the new research. Current EIR/EIS documents inadequately address the interactive effects of anthropogenic climate change (predicted to occur by the vast majority of climate scientists), and the development of large-scale solar projects and associated Urban Heat Island Effects (Millstein and Menon 2011) on Desert Tortoise persistence. More than 95% of the current range of desert tortoise will be eliminated by ongoing climate warming, based on new physiological and demographic models for reptiles (premised on methods presented in Sinervo et al. 2010), data from the IPCC IVth and Vth climate assessments (Worldclim.org, Hijmanns et al. 2005), and Regional Climate models available for the Desert Southwest region (Bell et al. 2004, and a new method for de-biasing errors in climate projections: Salazar et al. 2011). Given the Urban Heat Island Effect around solar projects (Millstein and Menon, 2012) and the projected mortality from road development (Gibbs and Shriver 2002, Boarman and Sazaki 2006), we demonstrate in the new research that the remaining climate refuges (<5% of current range) will be severely jeopardized by current solar energy projects and future projects.

Please contact me if you have any questions.

Sincerely,

Barry Sinervo, Ph.D.
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and
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References: **(1)** Bell, J. L., Sloan, L. C. & Snyder, M. A. Regional Changes in Extreme Climatic Events: A Future Climate Scenario. *Journal of Climate* 17, 81-87 ; **(2)** Boarman, W. I. and Sazaki, M. 2006. A highways road-effect zone for desert tortoises (*Gopherus agassizii*). Journal of Arid Environments. 65 : 94-101 ; **(3)** Gibbs, J. P. and Shriver, G. W. 2002. Conservation Biology, 16: 1647–1652; **(4)** Hijmans, R. J. et al. 2005. Very high resolution interpolated climate surfaces for global land areas. *Int. J. Clim.* 25, 1965-1978 ; **(5)** Millstein, D. & Menon, S., 2011. S. Regional climate consequences of large-scale cool roof and photovoltaic array deployment. *Env. Res. Let.* 6, 1-9 ; **(6)** Salazar et al. 2011. Comparing and Blending Regional Climate Model Predictions for the American Southwest. Journal of Agricultural, Biological, and Environmental Statistics, Volume 16, Number 4, Pages 586–605; and **(7)** Sinervo, B. *et al.* 2010. Erosion of lizard diversity by climate change and altered thermal niches. *Science* 328, 894-899.

Attachments (below):
Abstract to DTC, Ontario, CA, February 2014 and
Abstract to NACCB, Missoula, MT, July 2014
Abstract to NACCB, Oakland, CA, July 2012

Attachment 1: Abstract in the Desert Tortoise Council Proceedings, Ontario, CA, February, 2014

Prospects for *Gopherus*: Demographic and physiological models of climate change from 65 million years ago and the future projections under the impacts of solar development

Barry Sinervo, University of California, Santa Cruz

Models predict that anthropogenic climate change will generate extinctions in the next century. Current models assume that extinctions will be triggered by severe demographic challenges faced by populations experiencing warming or drying but model linking demography and climate are correlative at best. Here we develop new population viability models of ectotherm extinctions due to climate change, using literature data on demography including: survival, clutch size and clutch frequency. Models are also premised on ecophysiological principles that relate activity metabolism and daily activity restrictions due to warming climate (Sinervo et al. 2010; *Science* 324:894-899), and effects of drought. We apply the new models to predict extinctions of *Gopherus* in present and future timeframes. We also calibrate the extinction models against fossil tortoise distributions back to the Eocene, the warmest period in the last 65 million years. Models accurately predict paleodistributions of tortoises validated by fossil data and also reconstruct the biogeographic origins of turtle and tortoise radiations during the Eocene, Miocene, Pliocene and Pleistocene. We also test the model with the contemporary distributions of all *Gopherus* species.

Given the ability of the models to accurately predict the origin and dispersal of *Gopherus* and the ancestral genus *Hadrianus*, and the contemporary distributions of all western *Gopherus*, our model is likely to reliably forecast future distributions and local population extinctions. In the present day, the model indicates that many contemporary populations in the Western Mojave are currently declining in abundance due to climate warming and decreasing precipitation. By 2080 (A2A climate scenarios), *G. agassizii* will be collapsing in demography (population l <1) across the species range. Under reasonable CO_2 limitation strategies (“B” CO_2 limit scenarios), we predict that many of populations predicted to go extinct could sustain a viable demography, even in 2080. Therefore, controlling CO_2 could save tortoises from climate-forced extinction.

However, one strategy for limiting atmospheric CO_2 inputs entails deployment of solar farms across deserts. Recent climate models indicate that large-scale deployment of solar panels generates a powerful Urban Heat Island Effect in adjacent desert habitat, raising maximum daily temperatures by 0.4 – 0.75 °C. Applying results from these coupled atmospheric models in our new population viability models for *Gopherus*, we find that solar farms accelerate predicted extinctions by 50 years. Therefore, populations of *Gopherus* adjacent to solar farms may go extinct even before benefits of solar farms are realized (e.g., by 2080). In addition, the siting of twp solar projects (Ivanpah Valley, California City) threatens the only habitat predicted to sustain population demography in 2080, effectively eliminating climate refuges for *G. agassizii*.

While developed for *G. agassizii*, the model accurately predicts species distributions of *G. berlandieri*, *G. flavomarginatus*, *G. morafkai* as well as the enigmatic Baja Cape population of *G. agassizii*. Under the IPCC IVth climate assessment, both *G. agassizii* and *G. morafkai* are predicted to experience >95% extinction of all known contemporary populations. “New habitat” for all western *Gopherus* is predicted to shift 2000 km to the Central Plains, exactly where the genus was located in Eocene. Under newer IPCC Vth climate assessements, which use Representative Carbon Pathways, we predict complete extinction of nearly all *Gopherus* populations under a 1200 ppm CO_2 scenario. We emphasize that while prospects look bleak for *Gopherus* it can be rescued from climate-forced extinction with aggressive limits on CO_2 input into the atmosphere. However, current and proposed solar projects will only hasten extinctions and likely eliminate the last remaining refuges for *Gopherus* from climate warming.

Attachment 2: Abstract in the NACCB meeting proceedings, Missoula, MT, July 2014

Prospects for *Gopherus*: Demographic and physiological models of climate change from 65 million years ago to the future in the face of solar farms.

Barry Sinervo, University of California, Santa Cruz, et al (four other co-authors listed in the program).

Models predict that anthropogenic climate change will generate extinctions in the next century. Current models assume that extinctions will be triggered by severe demographic challenges faced by populations experiencing warming or drying but models linking demography and climate are correlative at best. Here we develop new population viability models of extinctions due to climate change, using literature data on demography including: survival, clutch size and clutch frequency. Models are also premised on ecophysiological principles that relate activity metabolism and daily activity restrictions due to warming climate (Sinervo et al. 2010; *Science* 324:894-899), and effects of drought. We apply the new models to predict extinctions of *Gopherus* in present and future timeframes. We also calibrate the extinction models against fossil tortoise distributions back to the Eocene, the warmest period in the last 65 million years. Models accurately predict paleodistributions of tortoises validated by fossil data and also reconstruct the biogeographic origins of turtle and tortoise radiations during the Eocene, Miocene, Pliocene and Pleistocene. We also test the model with the contemporary distributions of all *Gopherus* species.

Given the ability of the models to accurately predict the origin and dispersal of *Gopherus*, the ancestral genus *Hadrianus*, and the contemporary distributions of all western *Gopherus*, our model is likely to reliably forecast future distributions and local population extinctions. In the present day, the model indicates that many contemporary populations in the Western Mojave are currently declining in abundance due to climate warming and decreasing precipitation.

However, one strategy for limiting atmospheric CO_2 inputs entails deployment of solar farms across deserts. Recent climate models indicate that large-scale deployment of solar panels generates a powerful Urban Heat Island Effect in adjacent desert habitat, raising maximum daily temperatures by 0.4 – 0.75 °C. Applying results from these coupled atmospheric models in our new population viability models for *Gopherus*, we find that, ironically, solar farms accelerate predicted *Gopherus* extinctions by 50 years, powerfully interacting with the rising temperatures and drought impacts due to climate change.

Attachment 3: Abstract in the NACCB meeting proceedings, Oakland, CA, July 2012

Barry Sinervo, Dept. of Ecology and Evolutionary Biology, UC Santa Cruz
Climate forced lizard extinctions are coupled to dieback events and successional change in plants

Climate models forecast species extinctions and distributional shifts in upcoming decades, but many predictions lack validation and thus are relatively uncertain. Sinervo et al. (Science May 2010) compared recent and historical surveys for lizards on five continents and presented a physiological model that predicted the extinctions with high accuracy (R^2=0.72). We present new physiological measurements of operative model temperatures that validate the model for 3 of the original continental surveys. Furthermore, we validate the extinction model with new predictions and new extinction resurveys of several species of lizard in Europe and North America. Finally, we present new data on correlated changes in trees species that are correlated with the lizard extinctions. The tree death and branch die-back events foreshadow dramatic ecosystem level changes that will profoundly impact persistence of the lizard species of the world. Tree dieback events transiently elevate operative temperatures and thus elevate extinction risk. Furthermore, larger scale tree dieback events promote successional change that will alter species composition of lizards in those ecosystems. Any large scale alterations of the habitat such as deforestation in forest habitats or solar farms in desert habitats will alter local albedo, elevate local thermal environments and thus increase extinction risk of lizards.