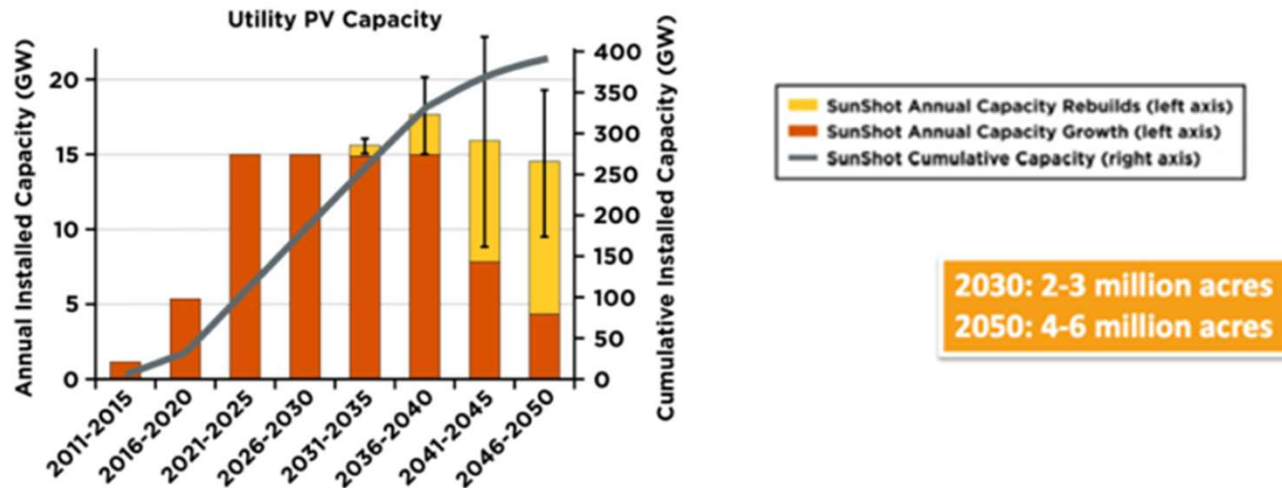


Soils and hydrology of solar farms in midwestern US

Sujith Ravi
Earth & Environmental Science



Land Use Requirements of Solar Deployment Projections



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Solar PV Power Potential is Greatest Over Croplands

Elnaz H. Adeb¹, Stephen P. Good², M. Calaf¹ & Chad W. Higgins²

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L. Krutwagen¹, K. T. Story, J. Friedrich, L. Byers, S. Skillman & C. Hepburn

Nature 598, 604–610 (2021) | [Cite this article](#)

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Land transformation for solar energy



Colocation of Solar PV & Vegetation

Native vegetation



Grazing, MN



Pollinator habitats, MN



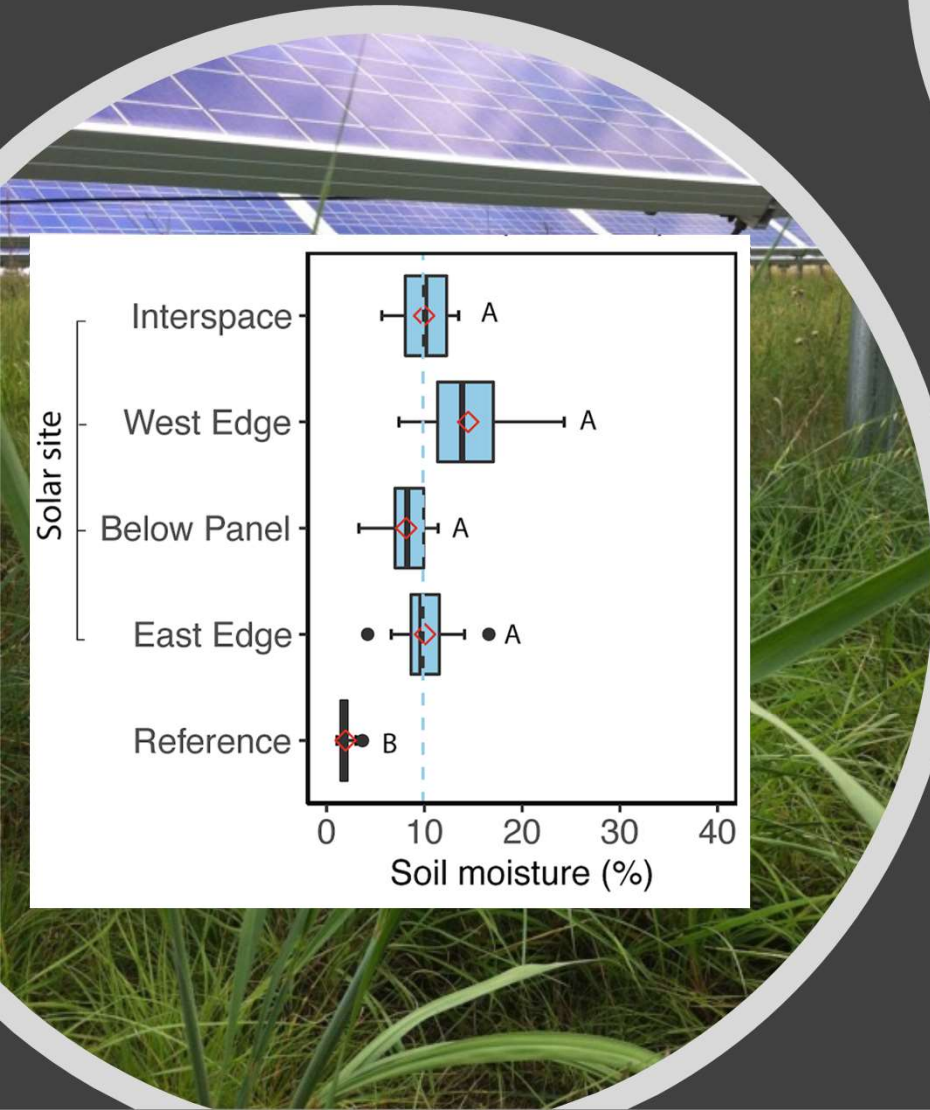
Rural microgrids, Indonesia

Vegetable crops, India

Licorice, Inner Mongolia

Over the past ten years, we studied the co-location of solar energy with crops/biofuels, grazing and/or pollinator-friendly native plants at multiple sites around the world, and the highlighted the environmental and socio-economic co-benefits.

(Ravi et al [2012](#), [2014](#), [2015](#), [2016](#), Choi et al, [2020](#), [2021](#), Bertel et al [2021](#), Towner et al [2021](#); Macknick et al., [2022](#).)



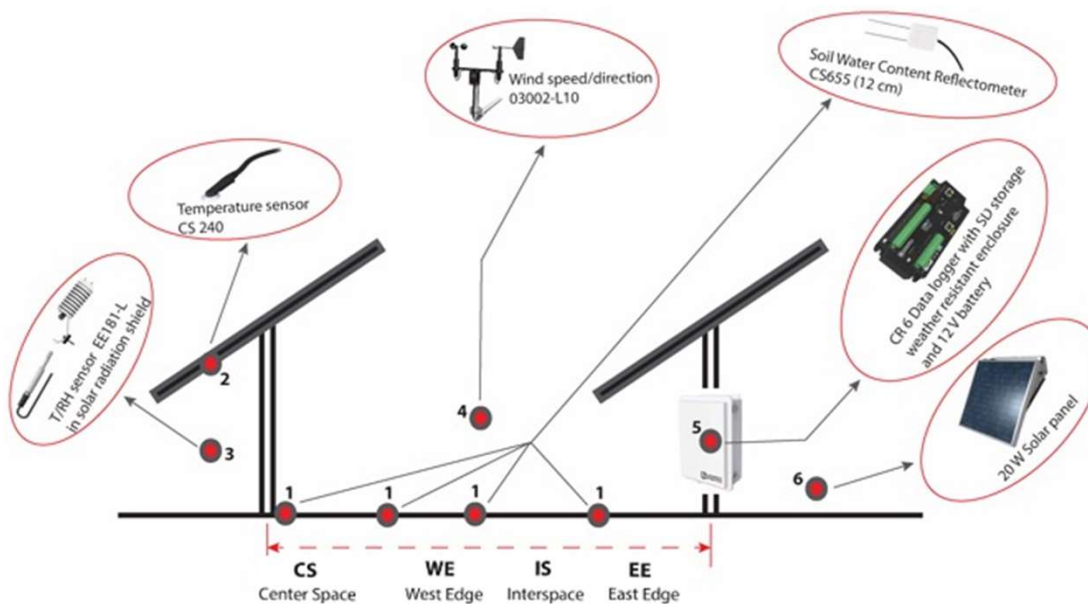
Revegetation at solar sites

- Heterogeneity in soil properties created and maintained by PV
- Incomplete recovery of the soil properties despite a decade after re-vegetation

➤ *PV construction while minimizing vegetation and soil impact easier than re-vegetation*

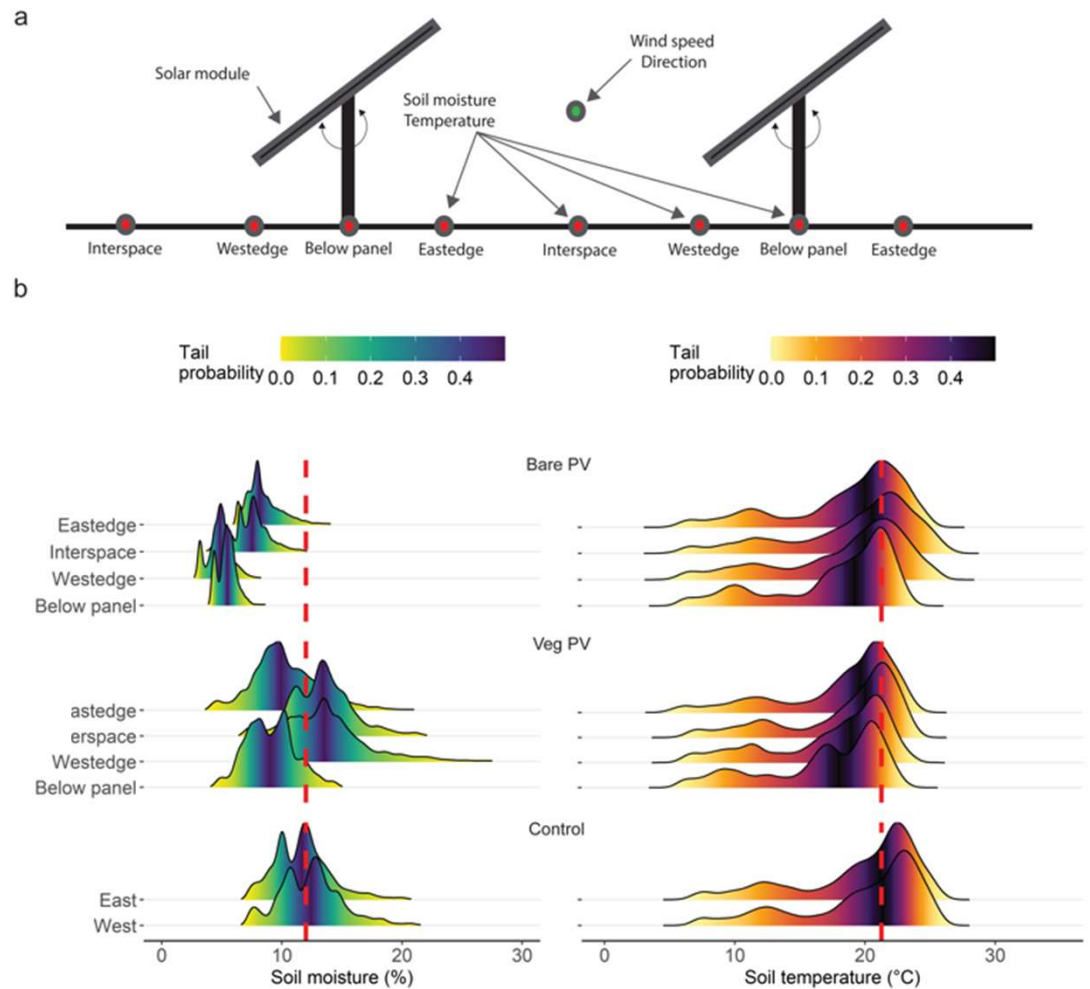
Field Experiments

- To provide critical data on microclimate, soil hydrological processes, vegetation community composition, and nutrient dynamics to inform developers, landowners, and state agencies to facilitate widespread deployment.
- Treatments : **Bare PV, Veg PV, Veg PV with grazing, and Control**
- Natural vegetation (seeding)



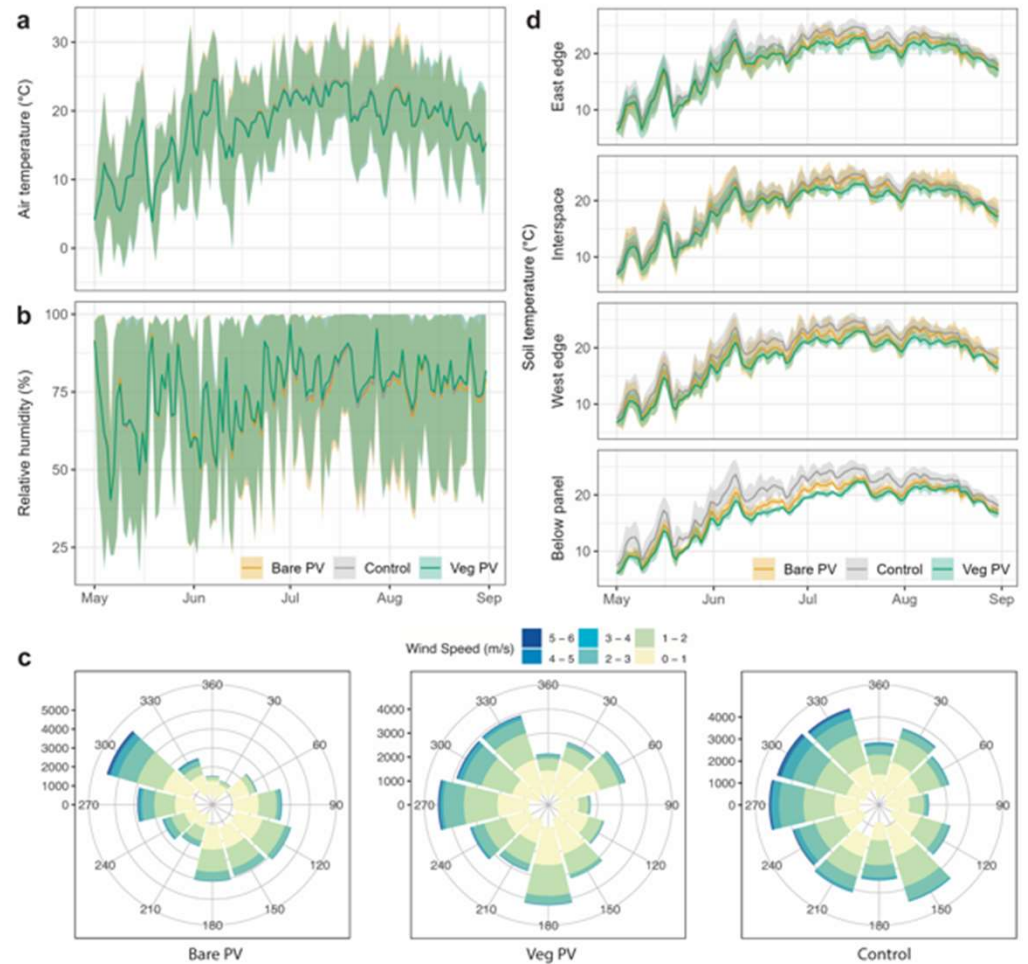
Soil moisture

- Solar panels intercept and redistribute precipitation and generate spatial variability of soil moisture.
- Vegetation cover can homogenize soil moisture and mitigate the variability through root uptake of water for transpiration



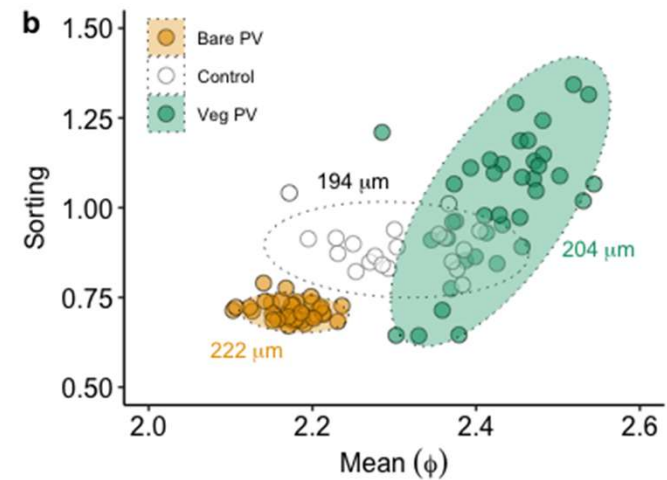
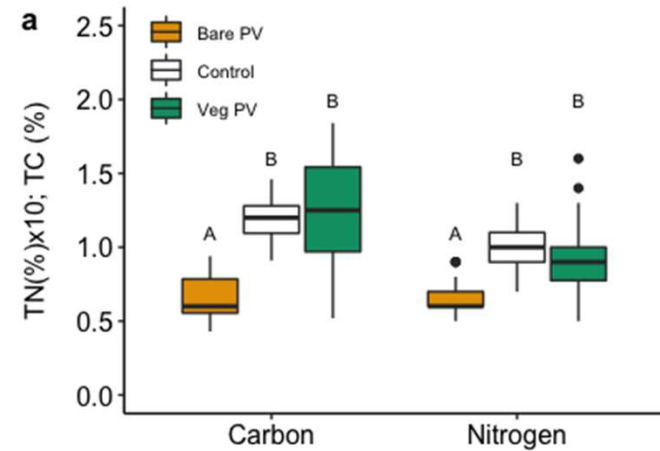
Microclimate

- Fine scale microhabitats created maintained by solar arrays induced by panels show greater temperature and soil moisture heterogeneity.
- Wind speeds lower and multi-directional at vegetated solar sites



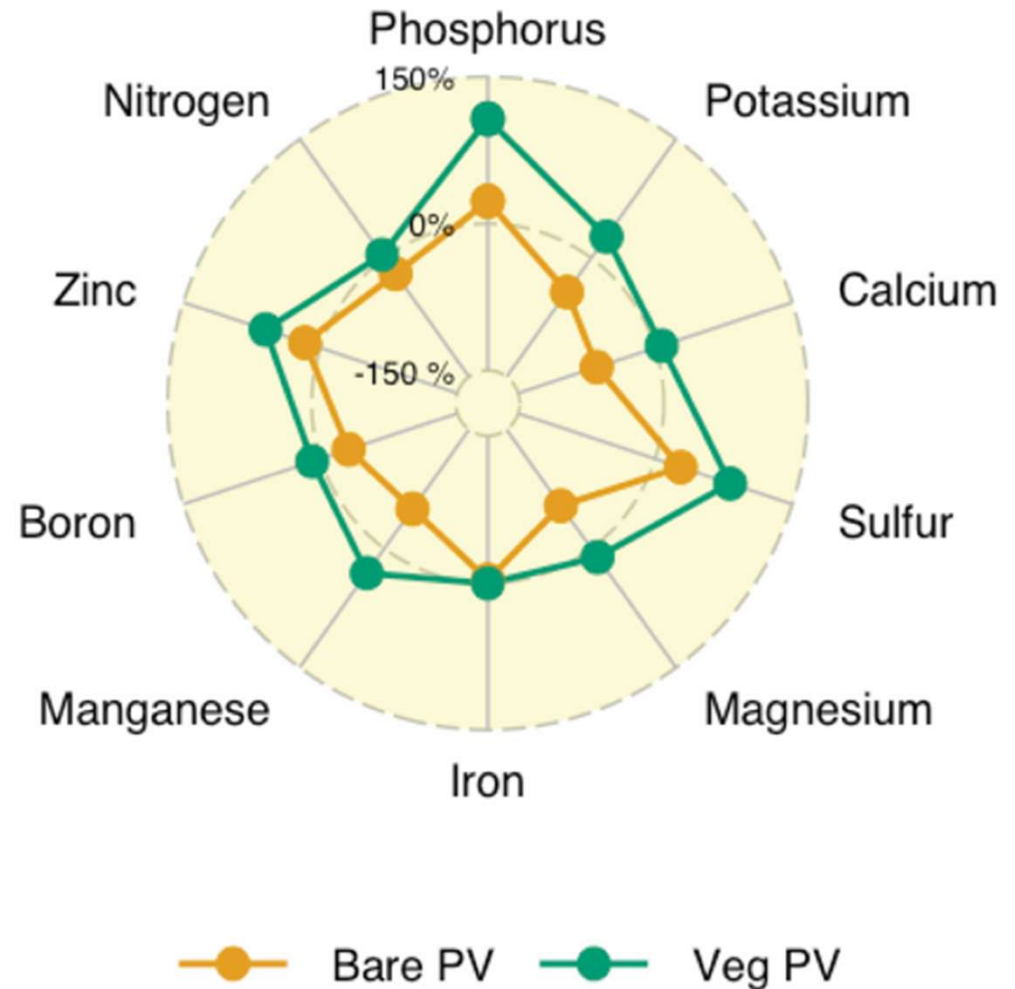
Soil Carbon & Nitrogen

- The total Nitrogen and Carbon levels were also significantly higher in the vegetated solar site than in the bare solar site.
- The loss of finer particles and the lower TC and TN and in the bare PV site is consistent with soil nutrient loss due to heightened erosion the absence of vegetation



Solar grazing

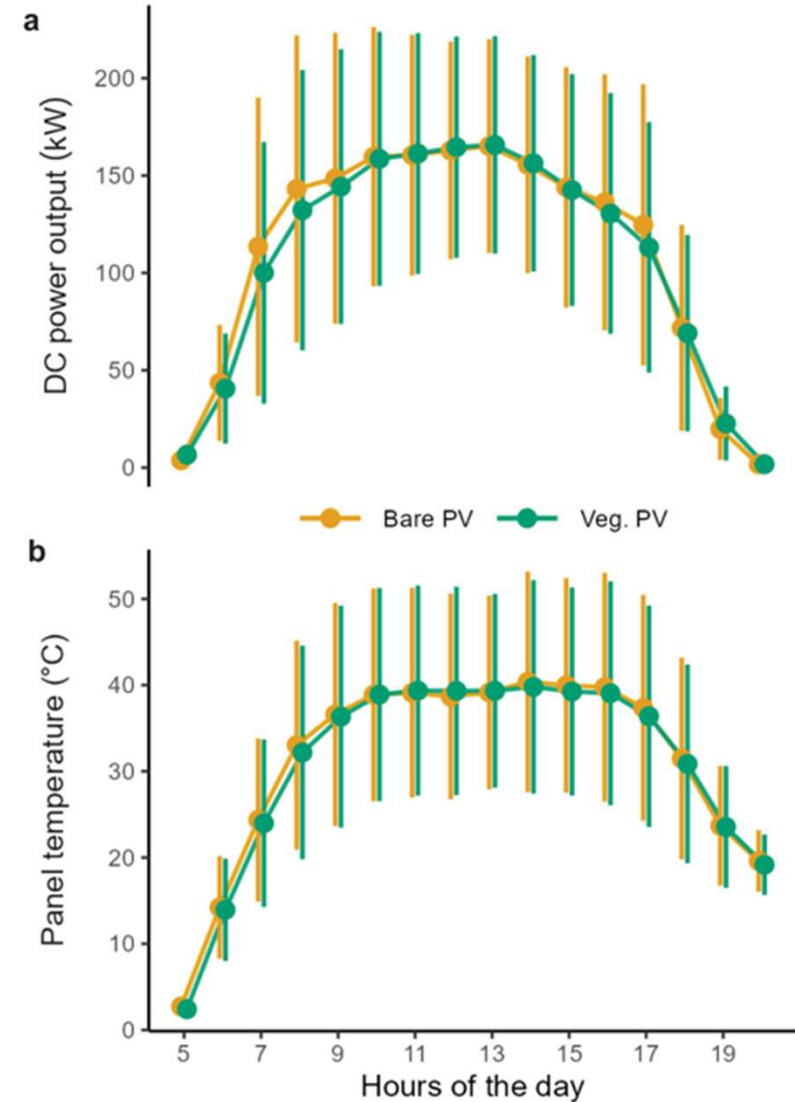
- Higher content of both C and N in grazed sites compared to ungrazed control areas.
- Higher macro and micronutrients essential for plant growth



Crop cooling effect

- PV panels in the colocated system may be cooler during the day
- Balance of latent heat energy exchange from plant transpiration relative to sensible heat exchange from radiation from bare soil
- **Effect of crop cooling on electricity generation are site specific !**

Choi et al., in review



Summary

- Dual land use
- Crop centric or solar centric
- Opportunities to expand agriculture
- Utilize marginal lands
- Maintain labor
- Co-benefits are site specific



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