SOLAR HARVEST POTENTIAL WITHIN LOS ANGELES COUNTY

An Alternative to the proposed Southern Owens Valley Solar Ranch Project

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ABSTRACT

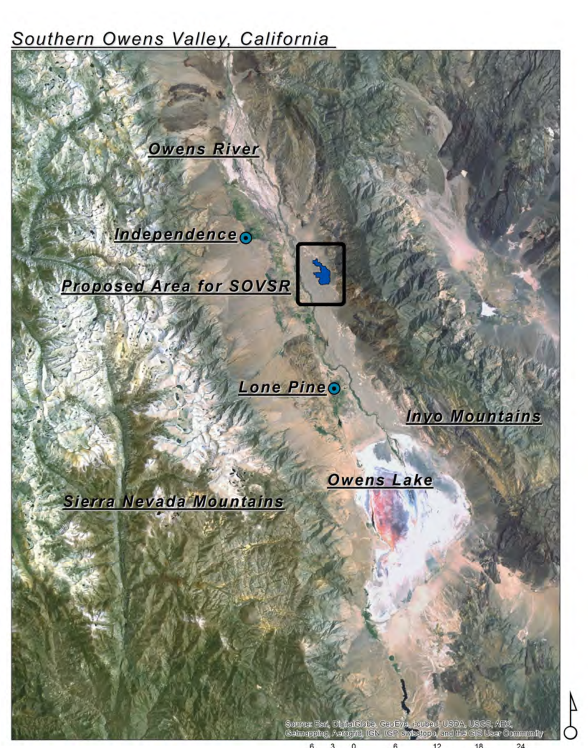
Pursuant to the guidelines established by the California Renewable Portfolio Standards established in 2002 (33% of all energy consumed in the state originating from renewable resources by 2020), the Los Angeles Department of Water and Power (LADWP) has recently proposed to construct a 486 hectare solar energy facility, known as the Southern Owens Valley Solar Ranch (SOVSR), in the Owens Valley of eastern California. The relationship between the City of Los Angeles and citizens of the Owens Valley is already tenuous at best (Kahrl 1983, Reisner 1993). Los Angeles has been exporting water from the Owens Valley since 1914, resulting in the single largest source of anthropogenic particulate matter pollution (PM10) in the western hemisphere (David & David 2013, Knudson 2014). According to comments in volume two of the draft Environmental Impact Report (EIR), opponents from the affected communities of the Owens Valley claim that the development of the SOVSR project would irreparably damage endemic flora and fauna, impact cultural and archeological resources, and transform the Owens Valley into a resource colony for Los Angeles (LADWP 2013). The authors believe that an alternative location exists that would have none of the aforementioned impacts, as well as generate an equivalent level of power derived from solar energy: Los Angeles County. The authors hypothesize that by utilizing the rooftop areas of publically owned buildings within Los Angeles County for energy harvest, LADWP would meet or exceed the amount of solar energy that could be harvested by the SOVSR. Without having to construct the infrastructure necessary to harvest, as well as transport, energy approximately 370 kilometers from the Owens River Valley to Los Angeles, LADWP would be able to create a solar project that would be cost effective, efficient, and environmentally conscientious.

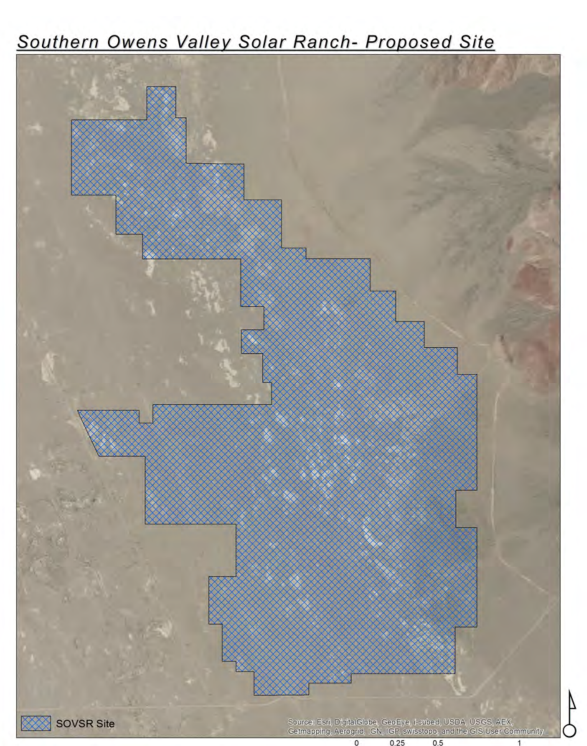
STUDY AREAS

1. Owens Valley, California

The arid Owens River Valley is located in Inyo County, California, wedged between the eastern extent of the southern Sierra Nevada Mountain Range and the western margin of the Inyo Mountains. The valley begins at the origin of the Owens River, near Mono Lake, and ends at the river's terminus at Owens Lake, 290 kilometers to the south. The valley is approximately 370 kilometers north of Los Angeles County, and is home to the agricultural communities of Bishop, Big Pine, Independence and Lone Pine, as well as the Manzanar National Historic Site, a former World War II internment camp.

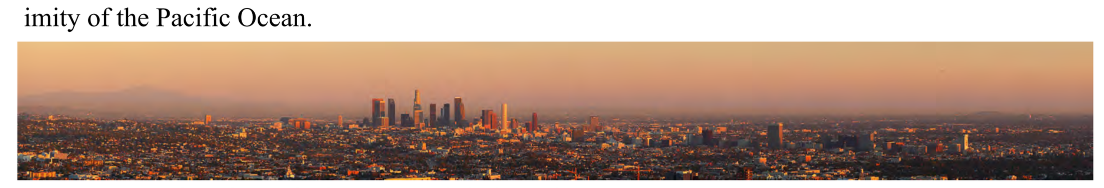
Looking west from Inyo Mountains towards Owens Valley, Owens River and Sierra Nevadas. Image courtesy of G.Thomas



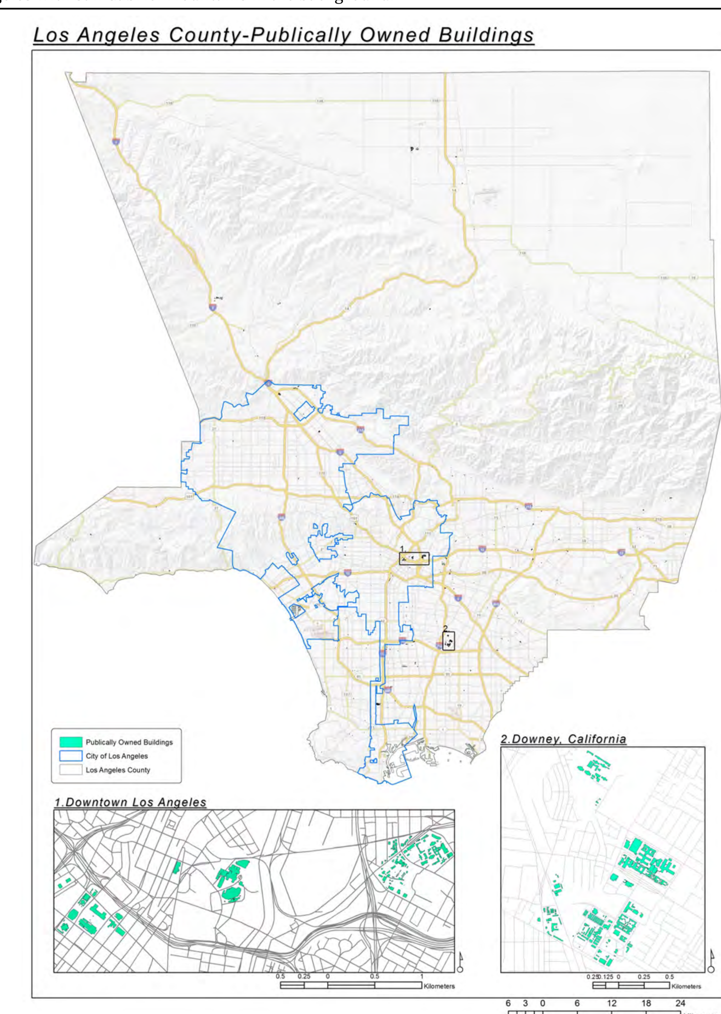


2. Los Angeles County, California

Home to the City of Los Angeles and 87 other incorporated cities, Los Angeles County has the highest population (9.8 million) of any county in the United States. With a total area of 10,570 kilometers, Los Angeles County is larger than the states of Rhode Island and Delaware, combined. Divided by the east-west running San Gabriel Mountains and buttressed by 112 kilometers of Pacific Ocean coastline, Los Angeles County has a varied topography, as well as climate. To the north, the land is hot, dry and sparsely populated. The central portion of the county is alpine in nature due to the dramatic rise of the San Gabriel's, while the southern section, where the vast majority of the counties inhabitants reside, has a sub-tropical, Mediterranean climate due to the proximity of the Pacific Ocean.



Downtown Los Angeles with San Gabriel Mountains in the background. Image courtesy of M.Field



PROCEDURES

In order to conduct an investigation of the validity of LADWP's proposed solar ranch in the Owens Valley, the solar power potential of both study areas (the proposed SOVSR site, as well as our proposed site of the rooftops of publically owned buildings in Los Angeles County) needed to be established. To determine the solar power potential of each proposed site, a solar radiation analysis was conducted using the "Area Solar Radiation" tool in ArcMap (version 10.2). The procedural steps for the analysis are documented below.

Area Solar Radiation

The Area Solar Radiation tool uses a DEM to determine the median latitude and elevation of the area being assessed to determine the incoming solar energy in units of watt hours per square meters. It has day/time settings that define the duration of analysis, as well as day and hour intervals that define the calculation frequency during the defined duration of analysis. There are options to adjust the influence of z-values, if units differ from x, y units, and there are two model types to choose from: (1) uniform sky—incoming diffuse radiation is isotropic; (2) standard overcast sky—incoming diffuse radiation is anisotropic with zenith angle. There are also diffusivity and transmittivity settings with range 0 – 1. Our analyses were run using settings that best represented the predominantly sunny climates of the study areas: 365 days with 14 day and 0.5 hour intervals in a uniform sky model, and default diffusivity and transmittivity values of 0.3 and 0.5, respectively.

Study Area 1-Southern Owens Valley Solar Ranch (proposed site)

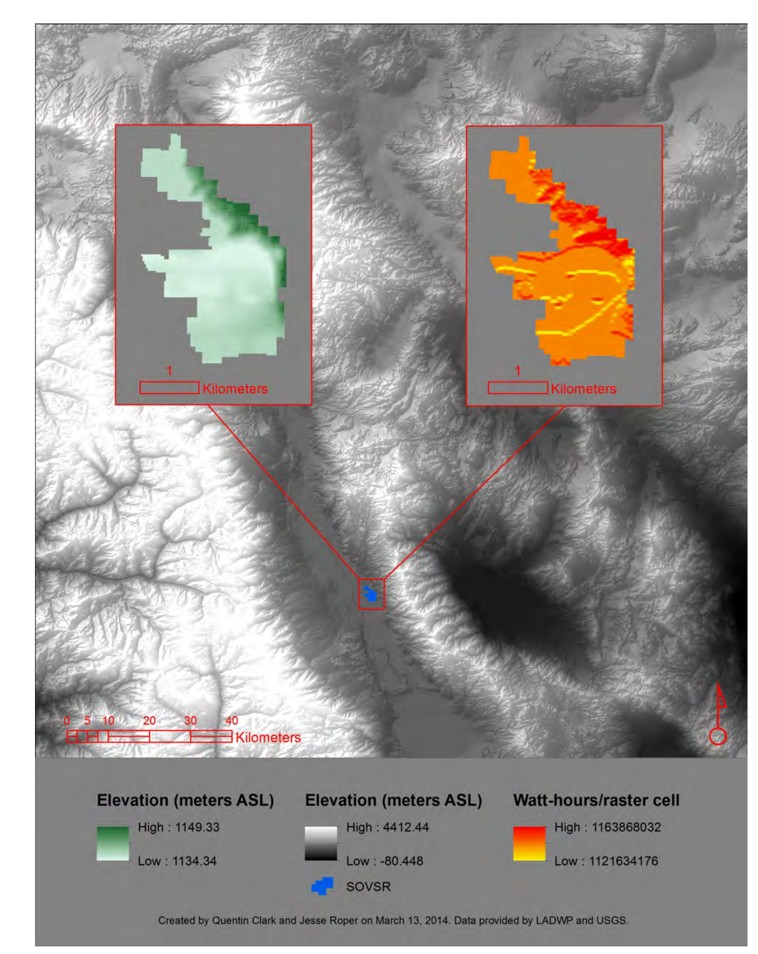
1. Locate Digital Elevation Model (DEM) for study area: Owens Valley, California.
2. Mosaic DEM using "Create Mosaic Dataset" and "Add Rasters to Mosaic Dataset" tools.
3. Digitized Polygon feature representing proposed Southern Owens Valley Solar Ranch (SOVSR) using imagery provided by LADWP Environmental Impact Report.
4. Projected digitized SOVSR polygon to match projection of Owens Valley DEM (NAD 83, UTM Zone 11N).
5. "Extract by Mask" tool used to create a DEM surface that coincided with area of SOVSR polygon.
6.Solar Radiation conducted analysis using "Area Solar Radiation" tool in to determine energy potential for SOVSR DEM surface (output of Step 5). SOVSR DEM surface used as input value in Solar Radiation tool. Solar Radiation settings set as "Clear Skies" over a 365 day period of time.
7. Solar Radiation figures, given in watt hours per square meter, converted from double float values to integer values using "Int" tool.
8. Watt hours per square meter converted to watt hours per raster cell by using "Raster Calculator" tool. Raster Calculator used to multiply the area of each cell (in square meters) by the corresponding watt hour per square meter value.
9. Watt hours per cell value converted from double float to integer value using "Int" tool. By doing so, an attribute table with values representing watt hours per cell ("Value") and number of cells per watt hour value ("Count") was created.
10. Total energy potential for SOVSR calculated by summing values of a newly created field. The new field was populated with values that were the products of the "Value" and "Count" fields.
11. Final unit of energy potential given in gigawatt hours. To convert to gigawatt hours, total watt hours of SOVSR (Step 10) was multiplied by 10-9, which represents gigawatt hours.

For Study Area 2- Los Angeles County

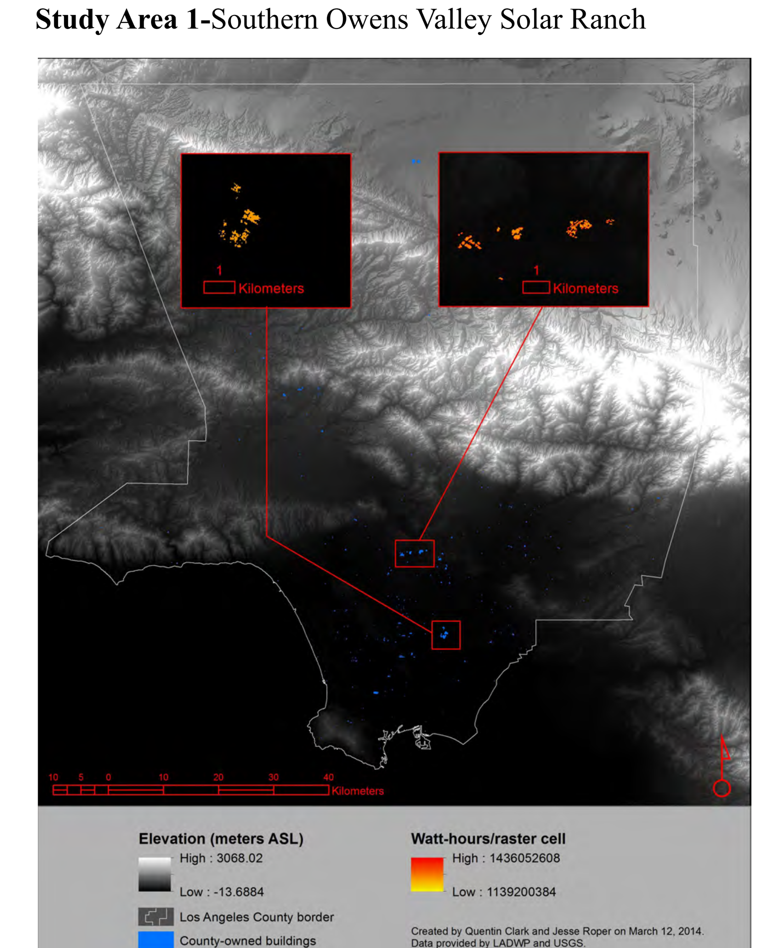
1. Locate Digital Elevation Model (DEM) for study area: Los Angeles County.
2. Mosaic DEM using "Create Mosaic Dataset" and "Add Rasters to Mosaic Dataset" tools.
3. Polygon feature class of rooftop outlines and areas of publically owned buildings acquired from the Los Angeles County GIS Data Portal.
4. Polygon features converted to raster surface using the "Polygon to Raster" tool. New raster surface representing rooftop areas of publically owned buildings created. Cells representing county owned buildings assigned a value of 1, all other cells assigned a value of "No Data."
5. Raster Calculator used to create a DEM surface that coincided with location of publically owned buildings. Surface created by DEM value multiplied by value of county owned building raster (elevation value * 1 or elevation value * No Data).
6. Solar Radiation analysis conducted using "Area Solar Radiation" tool in order to determine energy potential for county owned buildings DEM surface (output of Step 5). Publically owned buildings DEM surface used as input value in Solar Radiation tool.
Solar Radiation settings set as "Clear Skies" over a 365 day period of time.
7. Solar Radiation values, given in watt hours per square meter, converted from double float values to integer values using "Int" tool.
8. Watt hours per square meter converted to watt hours per raster cell by using "Raster Calculator" tool. Raster Calculator used to multiply the area of each cell (in square meters) by the corresponding watt hour per square meter value.
9. Watt hours per cell value converted from double float to integer value using "Int" tool. By doing so, an attribute table with values representing watt hours per cell ("Value") and number of cells per watt hour value ("Count") was created.
10. Total energy potential for publically owned buildings calculated by summing values of a newly created "Energy" field. The new field was populated with values that were the products of the "Value" and "Count" fields.
11. The final unit of energy potential given in gigawatt hours. To convert to gigawatt hours, total watt hours of SOVSR (Step 10) was multiplied by 10^{-9}, which represents gigawatt hours.

RESULTS & CONCLUSIONS

Results



Study Area 1-Southern Owens Valley Solar Ranch



Study Area 2-Los Angeles County Sites

Table 1— Area Solar Radiation analysis results

	Total surface area (hectares)	Latitude (°N)	Radiation analysis (watt hours/year)	Energy potential (gigawatt hours/year)
LA County	145	34.2168	3,472,771,082,240	3,473
OVSR	486	36.7569	7,126,085,268,224	7,126

Figures

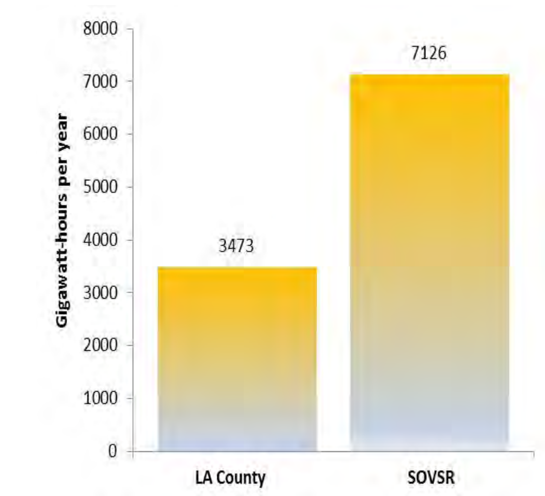


Figure 1—Total annual energy received for all rooftops of buildings owned by and within LA County (LA), and within area of the proposed Southern Owens Valley Solar Ranch (SOVSR).

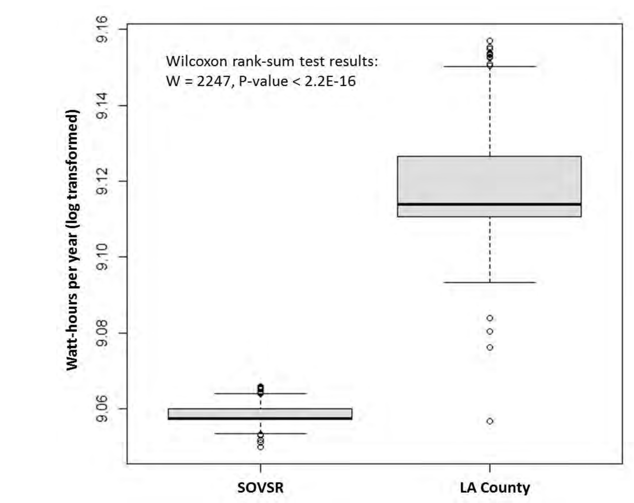


Figure 2—Boxplots showing the distribution of energy values calculated for both study sites. There is significantly higher energy received annually in LA County than in the Owens Valley (P< 0.05).

Conclusions

Based on the values provided by the "Area Solar Radiation" analysis (figure 1), it is evident that the rooftops of publically owned buildings in Los Angeles County are incapable of harvesting solar energy at a level that is equivalent to/or exceeds that of the proposed SOVSR site in the Owens Valley. However, the contrast in energy potential does not entirely reject the stated hypothesis. When a statistical analysis of the initial "Area Solar Radiation" outputs (watt hours/year) for each study area is conducted using a "Wilcoxon rank-sum test," it is revealed that Los Angeles County receives a higher level of solar radiation over the course of a calendar year (figure 2). Since there is a direct correlation between solar radiation exposure and solar power potential, the results of the "Wilcoxon-rank-sum" test demonstrate that Los Angeles County does have a greater ability to generate solar energy than the Owens Valley.

Extensive data inquiries were only able to retrieve the locations and dimensions of structures owned by Los Angeles County. The inability to acquire data for sites owned by the City of Los Angeles, the primary service area for the LADWP, significantly reduced the number of potential solar power sites for the Los Angeles County study area. This lack of data renders the solar radiation analysis, and subsequent potential solar power value, as only partially complete. The authors believe that the addition of city owned locations would increase the study area's solar power potential, perhaps to a level that would match or exceed that of the Owens Valley study area.

While it is clear that the proposed SOVSR site has a greater capacity to produce energy, the authors conclude that the stated hypothesis is neither rejected nor substantiated by the analysis conducted during this investigation. The "Wilcoxon rank-sum" statistical evaluation reveals that Los Angeles County receives a higher level of solar radiation than the Owens Valley. This, along with the potential for an even greater number of possible solar power sites in Los Angeles County than was used for this analysis, suggests that the Los Angeles Department of Water and Power should halt construction plans on the Southern Owens Valley Solar Ranch and consider the rooftops of publically owned buildings as a viable alternative.

The authors acknowledge that the analysis was limited in that it considered geographic location (latitudinal) and elevation, providing useful values for a comparison of harvestable solar energy, but ultimately removed from any biotic, structural and/or cultural factors.

The sanctity of ever-decreasing areas of undeveloped land in the western United States is at stake. Many residents of the Owens Valley are incensed by the potential precedent set by the intrusion of Los Angeles (Kostors 2014), claiming that their economy- built on the beauty of the western landscape-will suffer, and that they are being used as a resource colony by an outside hegemony. The authors firmly believe that developing renewable energy is paramount for humankind to effectively mitigate growing population demands as well as the effects of climate change. However, this must be done intelligently, with forethought and the creative use of resources and/or already developed land. We should beware of creating new problems when solving old ones; similar to logging old-growth timber, once done this damage cannot be undone.

ACKNOWLEDGEMENTS

Literary Resources

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Data Courtesy of:

1. Los Angeles County GIS Data Portal
2. Los Angeles County Planning Department
3. United States Geological Survey
4. ESRI

Imagery & Graphics Courtesy of:

1. Los Angeles Department of Water and Power
2. Inyo County

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