ABSTRACT

As carbon based fossil fuels become increasingly scarce, renewable energy sources are coming to the forefront of policy discussions around the globe. As a result, the State of Hawaii has implemented aggressive goals to achieve energy independence by 2030. Renewable electricity generation using solar photovoltaic technologies plays an important role in these efforts. This study utilizes geographic information system (GIS) and LiDAR with statistical analysis to identify how much solar photovoltaic potential exists for residential rooftops in the town of Kailua Kona on Hawaii Island. This study helps to quantify the magnitude of possible solar PV potential on residential rooftops within the study area. Three main areas were addressed in the execution of this research: (1) modeling solar radiation, (2) estimating available rooftop area, and (3) calculating PV potential from incoming solar radiation. Esri's solar modeling tools and high resolution LiDAR data were utilized to calculate incoming solar radiation on a sample set of digitized rooftops. Photovoltaic potential for the sample set was then calculated with the equations developed by Suri et Al. 2005. Sample set rooftops were analyzed using a statistical model to identify the correlation between rooftop area and lot size. Least squares multiple linear regression analysis was performed to identify the relationship between the slope, elevation, rooftop area and lot size explanatory variables and their influence on the modeled PV potential values. The equations built from these statistical analyses of the sample set were applied to the entire study region to calculate total rooftop area and PV potential. One parcel with real time PV production data was chosen for a ground truth comparison. This ground truth served as a means to evaluate the performance of the rooftop area calculations and the PV potential estimation methods. The total study area statistical analysis findings estimate photovoltaic electric energy generation potential for rooftops is approximately 190,000,000 kWh annually. This is approximately 17% of the total electricity the utility provided to the entire island in 2012. Based on these findings, full rooftop PV installations on the 4,460 study area homes could provide enough energy to power over 31,000 homes annually. Results from the ground truth comparison show the PV modeled values to be approximately 68 percent of actual PV production on the ground truth site. This work addresses a significant lack of scientific research regarding solar PV potential in the study area. The methods developed here suggest a means to calculate rooftop area and PV potential in a region with limited available data. This effort could be effectively replicated in other areas. This study also provides a launching point future studies addressing the larger issues associated with net energy metering capacity, grid stability and saturation as well as a growing need for a better understanding of the factors that influence solar PV potential.