Albedo Data for Bifacial PV Systems Update

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Introduction

For better performance estimates of bifacial PV systems and to reduce the risk for the PV and financial communities, the U.S. Department of Energy (DOE) funded the National Renewable Energy Laboratory (NREL) to develop albedo data sets for use in modeling and decision making. The data sets of ground albedo and associated meteorological data were developed by using existing SURFRAD and AmeriFlux measurement network data and data contributed by Canadian Solar, Inc. and SunPower Corp. The data sets include time-series data as well as summary information consisting of tabular monthly and yearly data and plots of monthly and hourly albedo values. A list of the measurement stations and their overall albedos are listed in Table 1.

Background

For mono-facial PV systems, the ground-reflected radiation typically comprises only 1% to 2% of the total radiation received by the PV module. Consequently, a rudimentary understanding of the ground albedo is adequate for predicting their performance. However, for bifacial PV modules where their benefit is determined by the additional radiation reflected by the ground to their backside, a better understanding of albedo values and characteristics is needed by both the PV and financial communities to better estimate performance and to reduce risk.

The albedo of a surface is the fraction of the incident irradiance that it reflects. Albedo data are derived from measurements by two horizontal pyranometers, one facing the sky and the other inverted and facing the ground. The resulting albedo is the irradiance reflected by the ground and measured by the ground-facing pyranometer divided by the global horizontal irradiance (GHI) measured by the sky-facing pyranometer.

Fig 1. Albedo measurements at NREL's Solar Radiation Research Laboratory.

Data Availability

The albedo data sets may be download from NREL's DuraMAT website at https://datahub.duramat.org/project/about/albedo-study. The data sets include time-series data as well as summary information of tabular monthly and yearly data and plots of monthly and hourly albedo values. Complete information about the measurement stations and their data is presented in a user's guide. This work will add more albedo data sets as they become available from contributions by the PV community.

Figures 2 and 3 are example plots of monthly and hourly albedos presented in the user's guide.

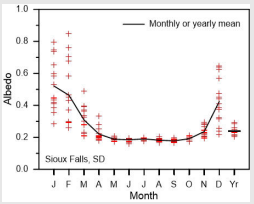

Fig. 2. Monthly and yearly albedo means for Sioux Falls, SD. The variability of albedo during the winter months is because the snowfall is variable from year to year.

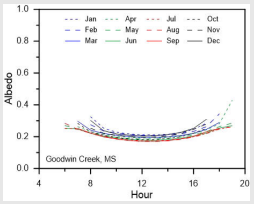

Fig. 3. Mean hourly albedos for Goodwin Creek, MS. The albedos are greater for early morning and late afternoon because of angular effects, and because the grass surface is more reflective to the longer wavelengths of the solar radiation present at those times.

Acknowledgment

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Table 1. Measurement Stations and Overall Albedos

StationID	Location	Data Source	Data Years	Ground Surface	Overall Albedo
BondvilleIL	Bondville, IL, USA	SURFRAD	24	Native grasses	0.247
BoulderCO	Boulder, CO, USA	SURFRAD	23	Sandy with exposed rocks, sparse grass, desert shrubs, cactus	0.199
DesertRockNV	Desert Rock, NV, USA	SURFRAD	20	Fine rock and scattered creosote bush	0.211
FortPeckMT	Fort Peck, MT, USA	SURFRAD	23	Native grasses	0.247
GoodwinCreekMS	Goodwin Creek, MS, USA	SURFRAD	24	Pasture grass and sparse deciduous trees	0.200
PennStateUnivPA	Penn State Univ, PA, USA	SURFRAD	20	¾ grass and ¼ crops	0.252
SiouxFallsSD	Sioux Falls, SD, USA	SURFRAD	15	Native grasses	0.238
ChangshuJiangsu	Changshu, Jiangsu, China	Canadian Solar, Inc	1.3	Concrete White-painted concrete	0.236 0.533
DavisCA	Davis, CA, USA	SunPower Corp.	0.8	Gravel, light to medium gray White tarp	0.145 0.568
LethbridgeAlberta	Lethbridge, Alberta, Canada	AmeriFlux	1	Mixed grass prairie	0.250
MedfordOK	Medford, OK, USA	AmeriFlux	3	Hay pasture	0.211
WoodwardOK_1	Woodward, OK, USA	AmeriFlux	4	Switchgrass	0.186
WoodwardOK_2	Woodward, OK, USA	AmeriFlux	4	Switchgrass	0.204
AudubonRanchAZ	Audubon Research Ranch, AZ, USA	AmeriFlux	10	Native grasses	0.217
BouldinCA	Bouldin Island, CA, USA	AmeriFlux	3	Alfalfa	0.221
BrookingsSD	Brookings, SD, USA	AmeriFlux	7	Pasture grass	0.262
CanaanValleyWV	Canaan Valley, WV, USA	AmeriFlux	6	Grassland	0.294
CorralPocketUT	Corral Pocket, UT, USA	AmeriFlux	7	Semi-arid grassland with 38-80% bare ground from livestock grazing	0.238
CottonwoodSD	Cottonwood, SD, USA	AmeriFlux	4	Grassland	0.181
DiabloCA	Diablo, CA, USA	AmeriFlux	3	Grassland	0.206
DukeFieldNC	Duke Field, NC, USA	AmeriFlux	5	Tall fescue grass mowed annually	0.203
FlagstaffAZ	Flagstaff, AZ, USA	AmeriFlux	6	Post forest fire grasslands	0.219
FermilabIL	Fermilab – Batavia, IL, USA	AmeriFlux	14	Prairie grass	0.221
FieldStationKS	Kansas Field Station, KS, USA	AmeriFlux	8	Grassland	0.193
KonzaPrairieKS	Konza Prairie, KS, USA	AmeriFlux	6	Grassland	0.190
TurfgrassFieldMN	Turfgrass Field, MN, USA	AmeriFlux	4	Turfgrass lawn	0.322
ReynoldsCreekID_1	Reynolds Creek, ID, USA	AmeriFlux	3	Low sagebrush	0.179
ReynoldsCreekID_2	Reynolds Creek, ID, USA	AmeriFlux	3	Mountain big sagebrush	0.231
RosemountMN	Rosemount, MN, USA	AmeriFlux	5	Grassland	0.247
SonoranDesertCA	Sonoran Desert, CA, USA	AmeriFlux	7	Desert	0.245
SouthGrasslandCA	Southern Californian Grassland, CA, USA	AmeriFlux	9	Grassland	0.165
McKenzieFlatsNM	McKenzie Flats, NM, USA	AmeriFlux	12	Desert Grassland	0.219
ShidlerOK	Shidler, OK, USA	AmeriFlux	4	Tall grass prairie	0.217
SantaRitaAZ	Santa Rita, AZ, USA	AmeriFlux	11	Semidesert grassland	0.204
TwitchellCA	Twitchell Island, CA, USA	AmeriFlux	5	Alfalfa	0.223
WalnutGulchAZ	Walnut Gulch, AZ, USA	AmeriFlux	15	Grassland	0.182
SmileyburgKS	Smileyburg, KS, USA	AmeriFlux	3	Tall grass prairie	0.210

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