IMPACT OF FOREST FIRES ON SOLAR PV ELECTRICITY GENERATION IN WESTERN UNITED STATES

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ABSTRACT

The total installed capacity of Solar PV in USA is reported to have surpass 20 GW by the end of first quarter in 2017. There is increased focus on ability of these solar farms to produce guaranteed amounts for better grid management. Thus soiling on the solar panels has been an important issue gaining much importance. Western United States battles with forest fires every year during summer-fall. The air quality in nearby region suffers greatly during these events, reducing the solar irradiance. In this presentation we present initial results on impact of electricity generation during forest fires in nearby states. The data has been taken from a small commercial PV installation in Logan, Utah. The results show up to 12.5% loss in electrical energy produced within first three days of fires reported nearly 150 miles from the site. It appears that although the fires continue longer the impact does die down within days.

INTRODUCTION

As the cost/Watt for solar PV generation is dropping rapidly, it is emerging as a viable renewable energy source. As more and more PV farms get installed, the question of reliability becomes important. The electricity generation is highly impacted by the local weather and climate conditions. Dust collection on solar panels reduce the amount of light reaching the cells and result in a loss in energy production. Local pollution levels in countries like India and China also produces haze in the atmosphere and reduce light intensity reaching the cells. Atmospheric aerosols influence the solar spectral and irradiance in urban areas [1]. Energy productions on solar PV plants gets impacted by dust and particulate matter in air [2].

In most of the Western United Sates especially, California, Idaho, Colorado and Utah summer months have several forest fires raging. During these forest fire the smoke and haze would have same effects as pollution on the light intensity. In 2016 alone there were about 67,743 reported forest fires affecting over 5.5 million acres of land, covering much more area in smoke.

In this presentation we report on the electricity production during the month of August 2017 within few days of reported fires with in 150 miles from the site.

EXPERIMENTAL SYSTEM

Site Location: Logan, UT 84321, USA
Local Coordinates: 41.7370° N, 111.8338° W
PV system Capacity: 13.4 kW
PV Panels: PV Panels: Kyocera model # KD210GX-LPU, 210 W Polycrystalline Silicon, Anodized Aluminum Alloy Frame
Electrical Arrangement: Irradiance: Horizontally Mounted Li200X Cosine Corrected, Silicon-based Pyranometer
Data Logger: Campbell Scientific CR 3000
Connected with inverters through RS232 port
AC current and voltage Transformers

Two Axis Solar Tracker, designed, built and installed by Jardine's Alternative Energy LLC, Farmington, UT. The tracker was parked horizontal for these experiments.

RESULTS AND DISCUSSION

Fire was reported in Atomic City, Idaho on August 2, 2017, 156 miles north of our PV installation in Logan, Utah. Another fire was reported in Powerline, Idaho on August 4, 130 miles north of the installation. There were also fires in Pole Creek and Albany, Wyoming. There was a fire in Pingree Hill, and several other fires in Colorado on August 2. Winds were about 10 km/h during this period and variable in direction. We analyzed data from Inverter C from July 29th to August 10th, 2017. A drop of 12.5% was observed in PV power production during the period July 30-August 3. Power levels started increasing and, by August 5, were almost back to previous levels. Table 1 summarizes the atmospheric particulate matter density (PM) during the period. The power dropped again during the next two days due to additional fires and atmospheric particulates.

Figure 1: The Solar PV system at Campbell Scientific Inc., Logan, UT

Figure 2: Location of the reported fires and PV site. The three locations are marked by red dots.

Figure 3a

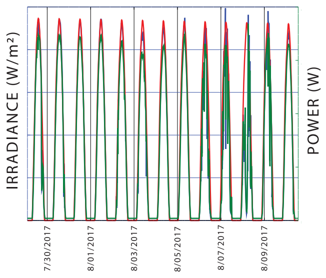


Figure 3b

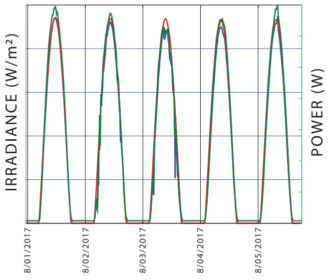


Figure 3: Solar Irradiance measured and calculated from a clear sky model, and production data from Inverter C. The red curve is irradiance calculated using clear sky model using PVLib in PVPMC [3]. Blue curve is irradiance measured during the event and green curve is the power produced by one of the inverters. (a) for the duration of July 29 to August 10, (b) for the duration of August 1 to August 5.

Figure 4a

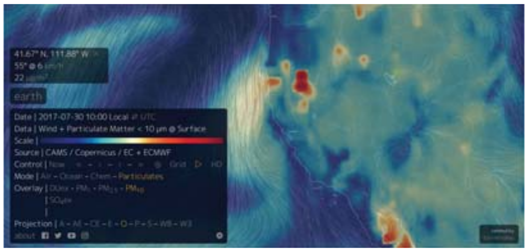
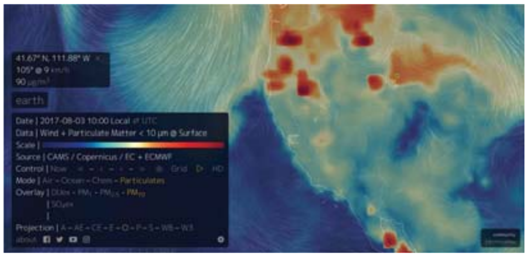


Figure 4a. Figure 4a. A screen shot of particulate matter concentrations in Logan, Utah (UT) on July 30 before the forest fires. The green circle represents the PV system location. The lines indicate the wind direction. Brown and red areas exhibit high particulate matter (PM) densities.

Figure 4b



4b. Same information on August 3, a sharp increase in PM10 can be clearly seen. Images taken from https://earth.nullschool.net. PM 1, PM2.5 and PM 10 peak values are summarized in the table 1 below.

Table 1: Particulate size on three days at Logan, UT. Taken from https://earth.nullschool.net.

PARTICULATE SIZE	JULY 30	AUGUST 3	AUGUST 5
PM_1 (μg/m³)	8	49	20
$PM_{2.5}$ (μg/m³)	16	91	28
PM_{10} (μg/m³)	7	26	13

CONCLUSION

The impact of forest fires can clearly be seen on the PV production. This will be an increasingly important issue in California and other parts of Western United States. Irradiance, visibility, precipitation, temperature and relative humidity sensors should be utilized to study the impact of particulates on PV performance. Sensors such as the CS125 and PWS100 could be utilized to measure visibility during such events. PV soiling can also be determined using the CR-PVS1 Soiling Index RTU monitor together with irradiance sensors to separate atmospheric attenuation of sunlight from PV soiling losses.

REFERENCES

1. K.V.S. Badrinath, Shailesh Kharol, et.al. J. Atm. Solar-Terr Phys., 69, 589-599 (2007).
2. Bergin, Mike H. and Ghoroi, Chinmay and Dixit, Deepa and Schauer, James J. and Shindell, Drew T., Environmental Science & Technology Letters, 4, 339-344, (2017).
3. J. S. Stein and W. F. Holmgren and J. Forbess and C. W. Hansen, 2016 IEEE 43rd Photovoltaic Specialists Conference (PVSC) 3425-3430 (2016).