ELF ELECTRIC AND MAGNETIC FIELDS EMISSION DUE TO ROOFTOP PHOTOVOLTAIC SYSTEM

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ABSTRACT

Electromagnetic fields are produced by a variety of natural sources and can also be generated by production and distribution of electricity. During the last few years, members of the scientific community as well as the general public have become increasingly concerned about the potential health hazards of exposure to electric and magnetic fields (EMFs) at extremely low frequencies (ELF).

Photovoltaics have emerged as one of the key technologies for generating electricity from renewable sources. In Egypt, the government encourages the individuals to install Rooftop Photovoltaic systems (RPVS) to meet the electrical energy demand and reduce s need from fossil fuel.

This paper investigates the electric and magnetic fields emission levels from RPVS 32 kWp due to the operation. The measurements carried out at different solar insolation levels.

The measurement results are evaluated according to the reference levels for safe public exposure. The conclusion finally derived is that the examined fields are so small values which are not dangerous and, therefore, are no cause for public concern from this green energy.

Keywords: *- Magnetic Field Measurement, Rooftop Photovoltaic Units, ICNIRP guidelines*

INTRODUCTION

Generally accepted guidelines have been established for safe public and occupational exposure to power-frequency EMFs. The reference levels for general public exposure to 50/60-Hz electric and magnetic fields are, according to the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines update are as follows:

For electric field strength, E < 5 kV m-1
For the magnetic flux density, B <200µ T
These levels for occupational exposure are:

For electric field strength, E < 10 kV m-1
For the magnetic flux density, B <1000µ T.

The ICNIRP raised the magnetic field exposure level for general public guideline which conflict with findings from some epidemiological research showing an apparent correlation between an approximate doubling in the very low risk of childhood leukemia and long-term exposure to average fields greater than 0.4 µT.

Many researchers studied the ELF magnetic field emission from transformer substations and Overhead lines but there are limited data available for the fields emitted from RPVS. The close proximity of these units to houses and workplaces causes anxiety amongst people over the possible health hazards from the resultant EMFs.

SITE DESCRIPTION

Alexandria Electricity Distribution Company (AEDC) installed its first RPVS on February 2014 with peak power 32kWp as shown in Fig.1. The most common technology used for roof PV units is mono-crystalline silicon panels which have higher efficiency. It consists of 78 mono-crystalline silicon solar panels, with a nominal power of 410 W for each panel. The array is connected to the distribution network via three-phase inverter. Although the latitude angle in this region is 31º, the tilt angle of RPVS panels has been designed to be 25 º.

MAGNETIC FIELD MEASURMENTS

The magnetic field measurements were performed on a 2m×2m grid at a height of one meter above the ground floor of the rooftop between RPV panels and around the inverter inside its room. The spot measurements for electric field were carried out at several points on the roof at a height of one meter above the ground floor. Fig. 2 shows the ground plan of the installed RPVs on the roof and the position of electric field spot measurement.

The spot measurements were recorded by the magnetic field meter PMM 8053 which are connected through fiber optics wire used to avoid interference together with a PMM EHP-50 probe. This connection between probe and the field meter was necessary in order to ensure that the electric field strength would not be perturbed by human presence. At the same time the line currents were measured by the inverter. These measurements also carried out at different solar insolation levels, which affect the output of PV units. Fig.3 shows the generated energy due to different solar insolation levels during the last year. Fig.4 shows the generated power due to different irradiation levels for two days (in summer and winter) which the measurements were carried out.

1 Alexandria Electricity Distribution Company

Fig.1 View of RPVS 32kWp installed

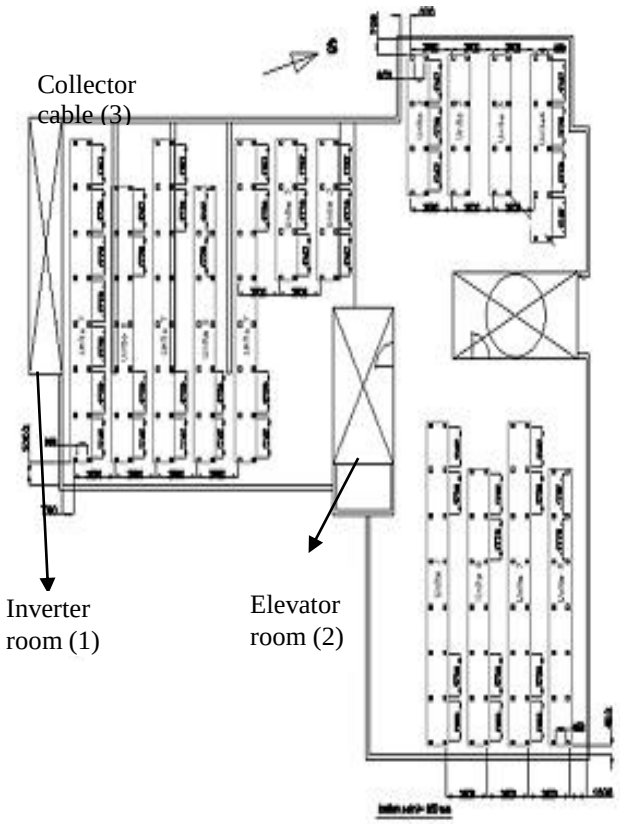

Fig2. The Ground Plan of The Installed RPVs on the Roof

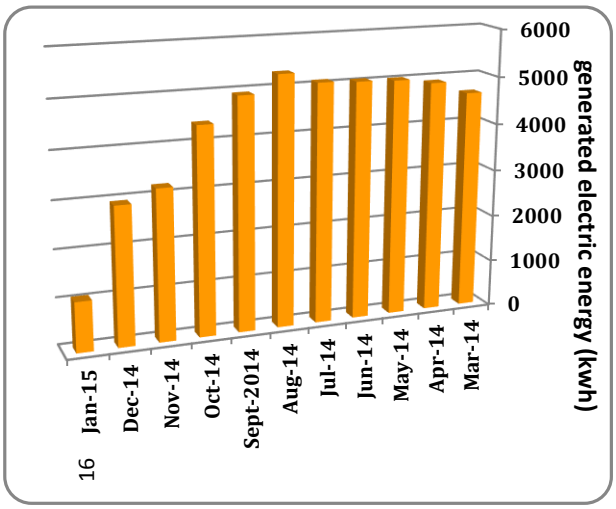

Fig.3 The Generated Electrical Energy Due to Different Solar Insolation Levels During a Year

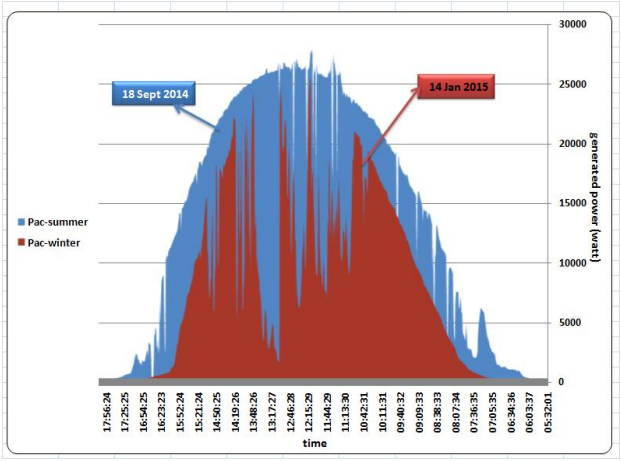

Fig.4 The Generated Power Due to Different Radiation Levels for Two Days (in summer and winter)

Case Study (1)

The EMF measurements were performed in PV systems mounted on 18th September2014, between 12 pm and 14:00 pm, under clear sky conditions and with an ambient temperature around 35oC. The generated power varied from 27.7kW to16kW during this period. Fig.5 and Fig.6 show the contour plots and the 3D plot for the measured magnetic field values. Magnetic field measured values around the inverter were in the range of 32µT-48µT.

Electric field measurements were declared in Table (1)

Table (1) The maximum electric field measured

Position	(1)	(2)	(3)
Electric field (V/m)	5.8	8.2	9.5

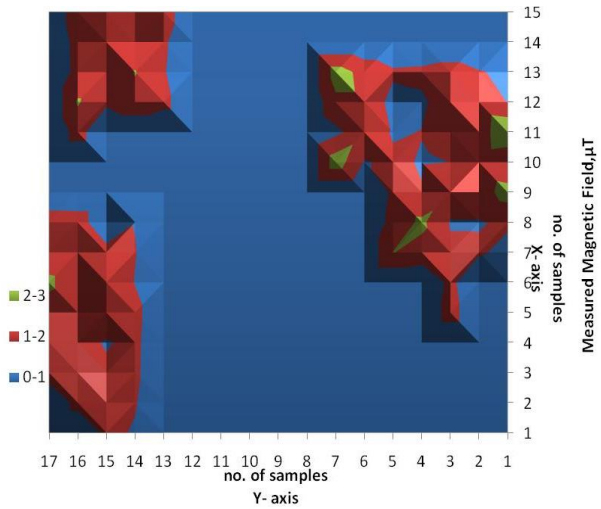

Fig.5 Magnetic Field Contour Plot for Case Study (1)

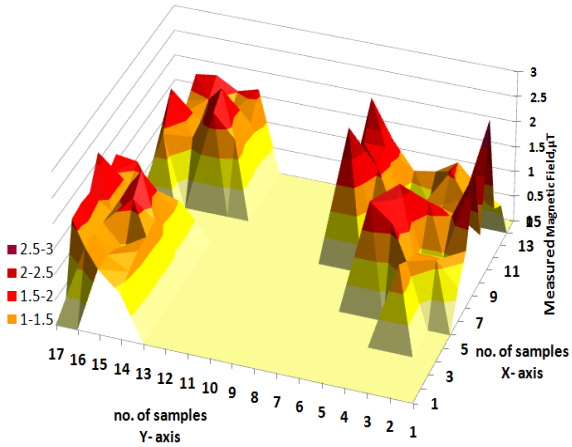

Fig.6 3D Plots for The Magnetic Field Measurement for Case Study (1)

Case Study (2)

The EMF measurements were performed in PV systems mounted on 14th January 2015, between 12 pm and 14:00 pm, under clear sky conditions and with an ambient temperature around 14oC. This ambient condition provided a very good performance of the PV units.

The generated power varied from 25.5kW to1.7kW during this period. Fig.7and Fig.8 show the contour plots and the 3D plot for the measured magnetic field values. Magnetic field measured values around the inverter were in the range of 24.4µT-35µT.

Electric field measurements were declared in Table (2)

Table (2) The maximum electric field measured

Position	(1)	(2)	(3)
Electric field (V/m)	2.8	8.65	3.5

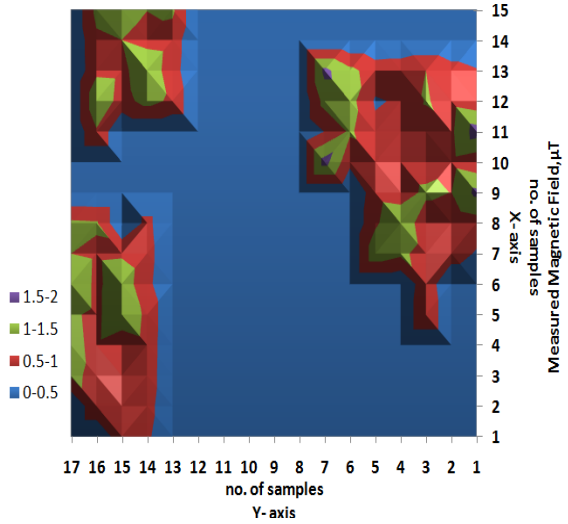

Fig.7 Magnetic Field Contour Plot for Case Study (2)

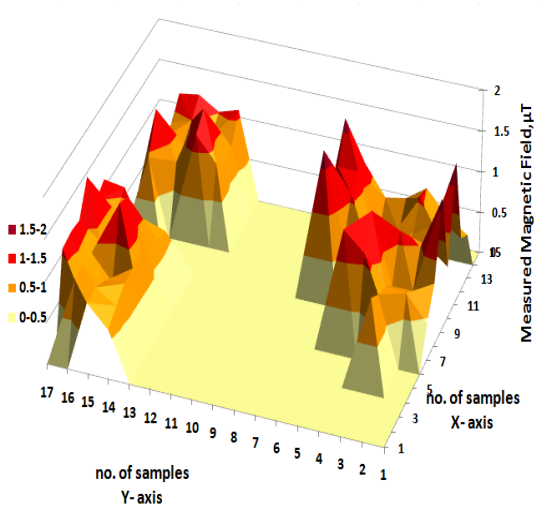

Fig.8 3D Plots for The Magnetic Field Measurement for Case Study (2)

RESULTS AND ANALYSIS

All the measured magnetic flux density values in these residences were also far below the reference level for safe public exposure. In Case study (1), the measurements were carried in summer. The generated power varied from 16kW to27.7kW during this period. The measured values at the RPVS positions on the roof were between 0.52 µT and 2.42 µT. This maximum value on the roof was at the back of inverter room, for that the maximum magnetic field value was measured at the inverter position, outside the roof and it was equal to 48 µT. The electric field measured values were between 5.8 V/m and 9.5 V/m, the maximum value 9.5 V/m was near the power cables collector tray. In Case study (2), the measurements were carried out in winter. The generated

power varied from 1.7kW to25.5kW during this period. The measured values at the RPVS positions on the roof were between 0.43 µT and 1.74 µT. Also, in this case the maximum value on the roof was at the back of inverter room, for that the maximum magnetic field value was measured at the inverter position, outside the roof and it was equal to 35 µT. The electric field measured values were between 2.8 V/m and 8.65 V/m, the maximum value 8.65 V/m was near the elevator room. It is noticed that, Fig.5 is similar to Fig.7 with different values.

CONCLUSION

In recent years, the general public and working personnel have become increasingly concerned about the health hazards of exposure to ELF EMFs.

This paper investigates the electric and magnetic fields emission levels from RPVS 32 kWp due to the operation. The measurements carried out at different solar insolation levels.

The measured electric field strength values in all cases were extremely lower than the reference level for safe public exposure, which is equal to 5kV/m. Also, the measured magnetic field values remained far below the relevant reference level for safe public exposure for magnetic field even around the inverter while maximum value recorded was 48 µT in its room.

Finally, the conclusion derived is that the examined fields are so small values which are not dangerous and, therefore, are no cause for public concern from this green energy.

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