The International Amateur Radio Union (IARU) is a Non-Governmental Organisation representing the interests of Radio Amateurs throughout the world, including all Member States of the European Union.

Solar energy systems, which include Solar PV, are a progressive technology whose use is to be encouraged. However, there are certain *caveats* to be noted in deployment and on-going use. In this context IARU would like to make some broad comments regarding the environmental impact of photovoltaic systems. IARU would be happy to elaborate on any of the points made or make available our research data.

The situation regarding Solar PV "optimizers" is particularly problematic. While, from an efficiency perspective, optimizer use is promoted and encouraged, optimizer high frequency switching harmonics can contribute significantly to radio spectrum interference and pollution while giving a fairly marginal efficiency improvement of the order of 2%. Indeed, in a research paper published by the University of Southern Denmark [1] on the impact of Optimisers for PV-Modules the author concluded that "The common marketing claims of additional energy production by applying optimizers could not be confirmed by this experiment. In fact, there are only very few scenarios where the use of optimizers improves the system performance."

Writing in the *bulletin.ch* a Swiss trade journal published by VSE and Electrosuisse, Prof. Dr. Baumgartner [2] concludes that "in the case of the actually measured components, the annual performance advantage of MLPE shrinks to around 2%".

The EMC Directive (2014/30/EU) deals with the conditions for placing apparatus on the market; it also recognises that a combination of CE marked apparatus may not itself meet CE standards. While there are rules regarding so-called "fixed installations" such as Solar PV, in some cases testing is only required following a complaint. Furthermore administrations in some Member States appear not to have sufficient resources to police disturbances emanating from such "fixed installations"; on the other hand some Regulators have already taken steps to remove non-compliant systems from the market.

One further difficulty is that EU Directives such as the LVD, EMCD and RED are focussed on placing on the market and do not address issues arising during the product life-cycle adequately. In practice both apparatus and installations may deteriorate with time thus contributing to unacceptable levels of background disturbance.

Optimizers are often retrofitted to Solar PV systems and the resulting combination of apparatus and cabling, acting as an antenna, can lead to the unintended radiation of the high-frequency harmonics.

Issues with interference from these optimizers are not new. A paper [3] from the Netherlands regulator presented at the Commission's EMC WP expressed concerns at interference to the security services using TETRA/C2000 in the 380-385 MHz band, typically from solar installations on private homes, specifically fixed installations incorporating optimizer. The paper questioned whether optimizers were adequately covered by standards and whether they could be regarded as "fixed installations" under the EMCD.

An EMC ADCO [4] report on the 11th joint cross border market surveillance campaign determined that only 25% of solar panel inverters were compliant with emissions requirements.

An unclassified report by FMV, the Swedish Armed Forces' Material Administration [5], describes a test to investigate the electromagnetic emission profile from a photovoltaic (PV) installation. The conclusion was that very strong emissions (compared to ITU man-made noise levels) were detected from the PV installation in a major part of the measured frequency range up to 1 GHz. It is reasonable to assume this frequency range is used by radio services such as commercial, public, aviation, government, security and military which could be affected by theses disturbances.

photovoltaik.eu, a journal of solar technology for installers, planners and architects, in a recent cover story on EMC [6] discusses how, under certain circumstances, solar arrays with DC optimizers emit unwanted frequencies that interfere with amateur radio. Professor Emeritus Heinrich Häberlin of the University of Bern, a member of USKA, the Swiss national amateur radio society, and an expert of many years standing on photovoltaic systems describes the difficulty of getting manufacturers to admit that such systems cause interference and to execute remediation. In a technical paper made available to IARU (Mitigation Results at a PV Plant with Optimizers disturbing Amateur Radio Reception at a distance of 75m) Dr. Häberlin details the measurement methodology he used and compares measured spectra before / after mitigation measures.

In the same edition there is an interview [7] with Emmanuel de Raemy, an expert on electromagnetic compatibility (EMC) and non-ionising radiation (NIR) at the Swiss Federal Office of Communications (OFCOM) in Biel, in which he describes how the Swiss supervisory authorities analyse sources of unwanted interference and warn operators of solar systems that installations employing optimizers and causing unacceptable levels of disturbance may face shutdown. According to de Raemy it's not just about the radio amateurs. It can be assumed that many more services are disrupted, but those affected do not recognize this as a disruption due to a lack of knowledge and therefore do not report anything to them. An appalling vista!

The German national amateur radio society DARC has instituted the ENAMS project[8]. ENAMS stands for Electrical Noise Area Measurement System and is an automatic receiving system distributed across Germany to record the interference level in the frequency range from 66 kHz to 31 MHz.

The ENAMS project was started by DARC because general interference measurements were no longer carried out by the German Federal Network Agency (BNetzA) after 2011 and therefore the increase in the general interference level in recent years due to the proliferation of disruptive electronics in residential and commercial areas is no longer documented. The ENAMS consists of more than 50 receivers installed in several countries that scan the entire frequency range from longwave (66 kHz) to shortwave (31 MHz).

By way of illustration of the effects of optimizers the succeeding figures are spectrum plots from a DARC ENAMS receiving installation at Ulm, Germany, taken recently. These are typical of the plots from many of the ENAMS stations.

The spectrum display is from 66 kHz to 31 MHz and the Field strength is calibrated to an accuracy of ±2dB. The measurement is made in a standard 9 kHz bandwidth.

Figure 1 a spectrum plot taken at midnight shows users of the short-wave bands with very little signals above 15 MHz. Solar PV is not operating at this time.

Figure 2 shows the situation at mid-day. The comb-like spikes visible from about 14 MHz are characteristic of Solar PV optimizers. There is little evidence of Solar PV below 10 MHz. This is probably because the length of the wiring in the PV installations is too small a fraction of a wavelength to radiate effectively.

Figure 3 is an enlarged detail of Figure 2 from 26-31 MHz. The spikes separated from each other by 200 kHz are typical of a particular make of optimizer.

The plots demonstrate that disturbance and unwanted signals from optimizers are very real.

In summary our concerns are not with solar technology but with the potential pollution from so-called optimizers.

The Radio Spectrum is a finite natural environmental resource and pollution of the radio spectrum should be considered on a par with other pollution, especially as new technologies are relying more and more on radio. It would be unfortunate if hydrocarbon pollution was replaced by electromagnetic pollution.

References

[1] Franke, T. (2019). The Impact of Optimizers for PV-Modules: A comparative study. Mads Clausen Institute, University of Southern Denmark.

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[3] EMC(28)17. NL interferences caused by solar panels.

[4]EMC-ADCO-48(20)03.3.1 - Report 11th EMC Market Surveillance Campaign v2.

[5] FMV (2020) 20FMV5518-2:1 Technical EMC report - Site T

[6] Schwarzburger, H. (2020). Elektromagnetische Verträglichkeit von DC-Optimierern. Photovoltaik 02/2020, pp.12-15

[7] *ibid*. pp. 16-17

[8] DARC (2022) *www.enams.de*

IARU Region 1 PRC Chair

Séamus McCague

April 2022

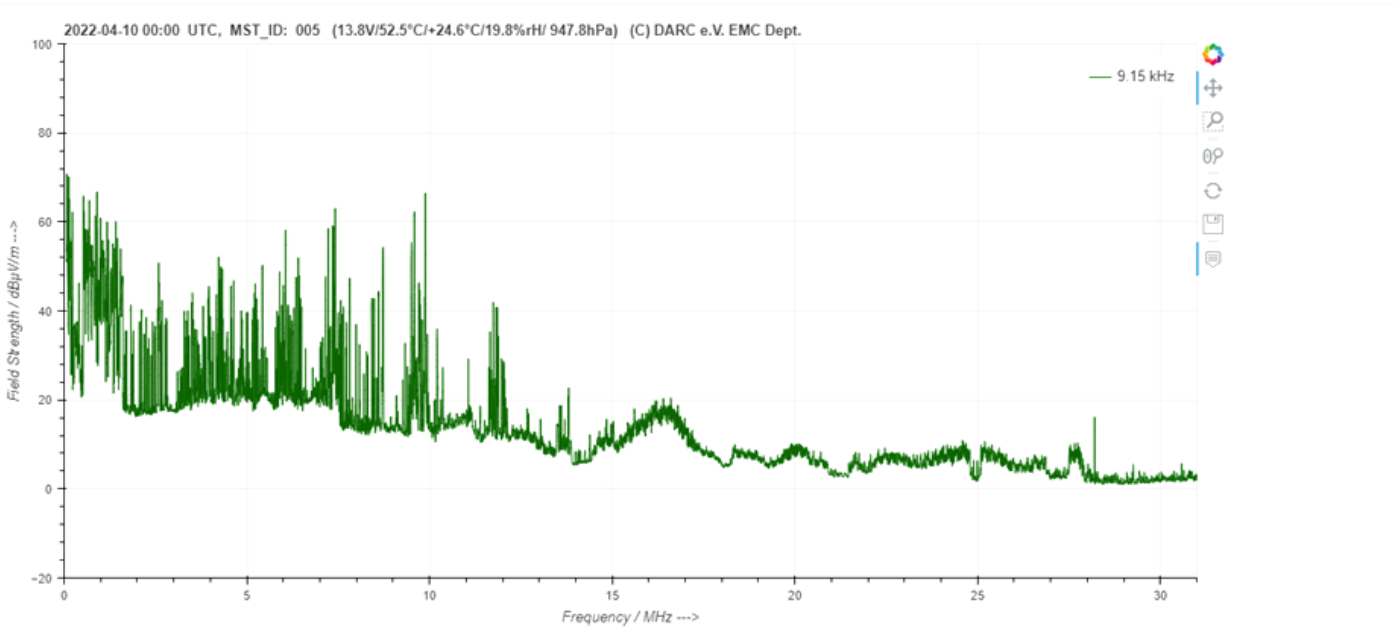


Figure 1

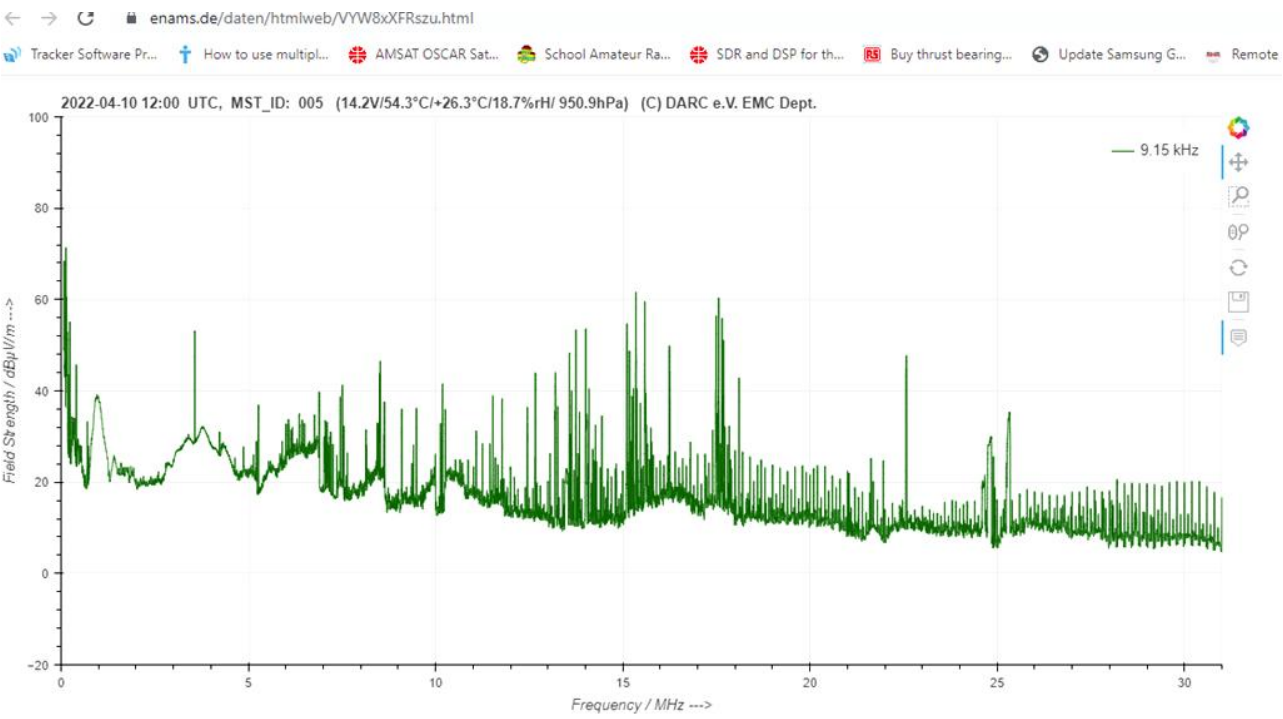
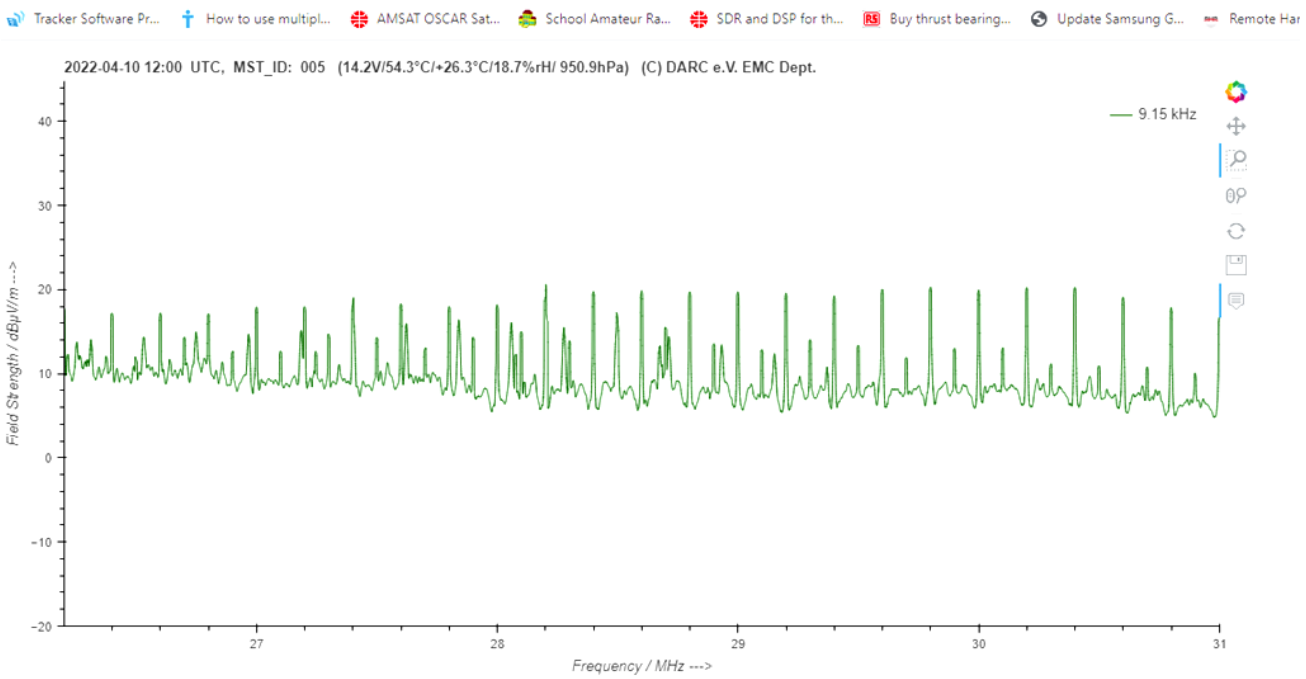


Figure 2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9.15 kHz
Field Strength / dBµV/m --->
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Frequency / MHz --->

Figure 3