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Recognizing and Responding to RFI from PV systems



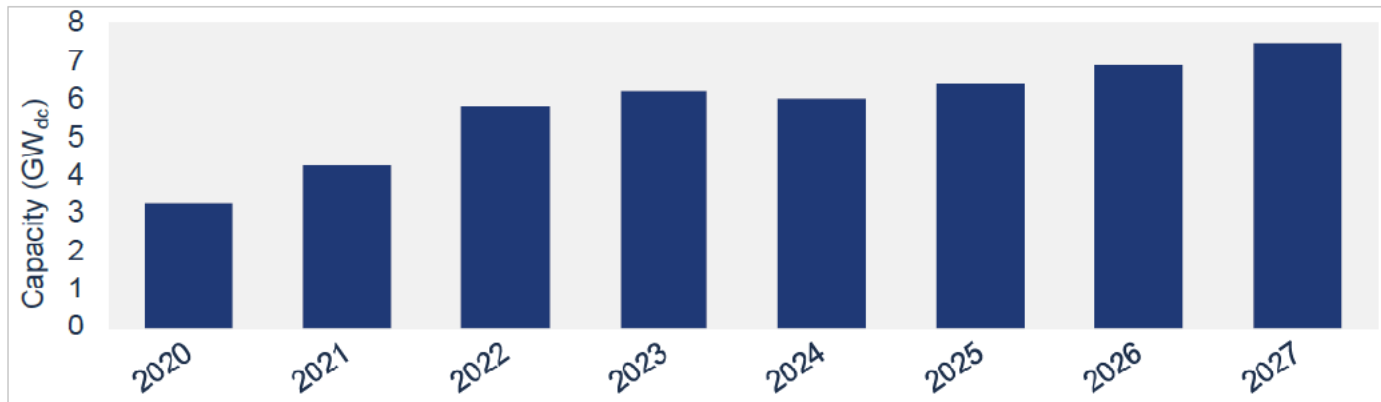
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Solar PV Systems - Landscape

- Residential installations (ref: <https://www.seia.org/research-resources/solar-market-insight-report-2022-q4>)

Residential solar installations and forecast, 2020-2027

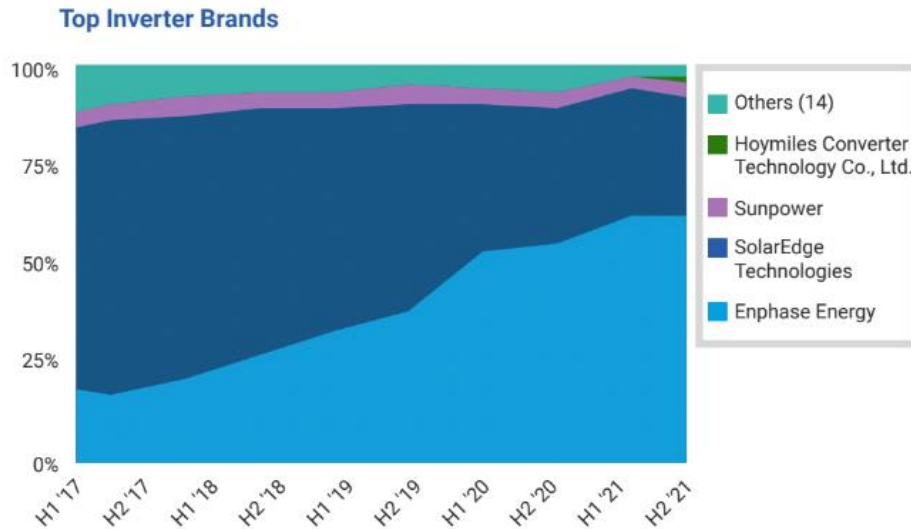


Source: SEIA/Wood Mackenzie Solar Market Insight Report, Q4 2022

Solar PV Systems - Landscape

Major Vendors of Module Level Power Electronics (MLPE)

- Enphase
- SolarEdge
- Generac (Sunpower)



Reference: [Top Inverter Brands](#)



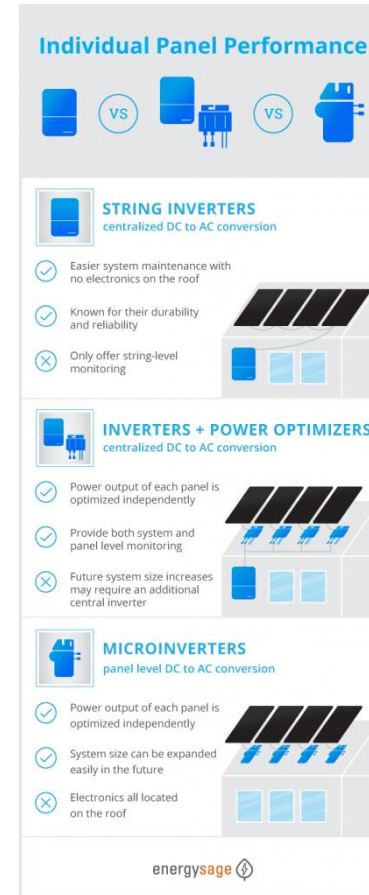
Solar PV Systems

Technology

- Enphase – microinverters located at each PV panel
- SolarEdge – optimizers (roof) with central inverter
- Generac – string inverters

Technology reference:

[String Inverters vs. Power Optimizers vs. Microinverters | EnergySage](#)



Solar PV Systems

Regulatory Framework

- Conducted emission limits only for below 30 MHz
- Radiated emission limits apply above 30 MHz
- Harmful interference provisions apply to the operator
- System components (e.g., inverters) meet Part 15B conducted emission limits
 - [SolarEdge System Design](#)
 - [Are Enphase Microinverters FCC compliant? - Support | Enphase](#)
- Reducing emissions radiated to our antennas is, in effect, voluntary on the part of the vendors



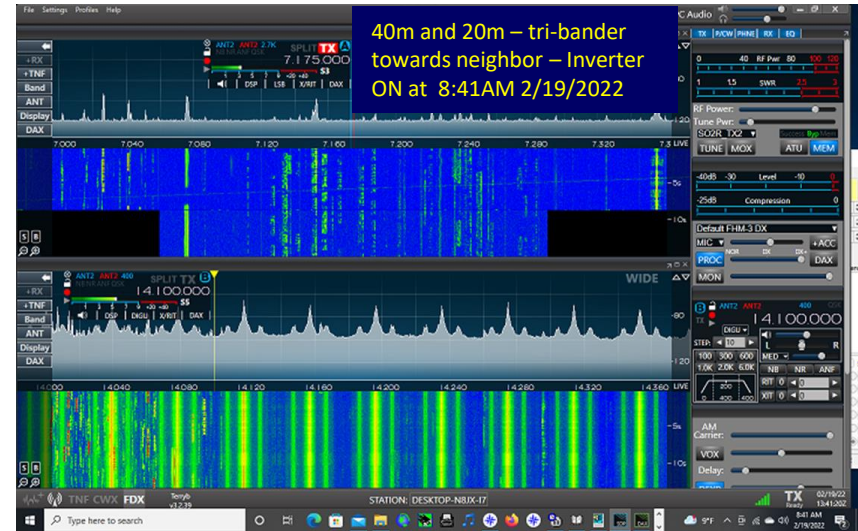
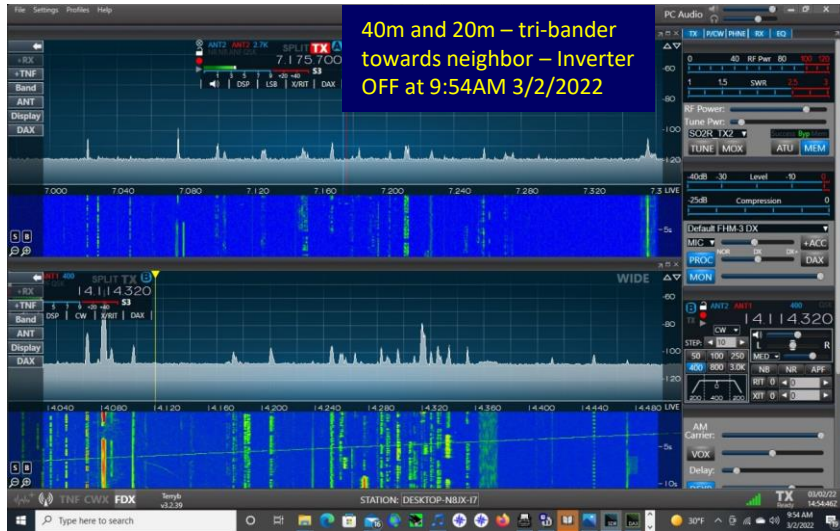
Solar PV Systems

Recognizing RFI from Solar

- Cause and effect
- Changes with time of day
- Neighbor can turn it off and the noise goes away
- Directional correlation
- Usually the system is either on the ham's house or at a nearby neighbor
- For the most part, an HF issue



RFI Examples–Generac (neighbor system)



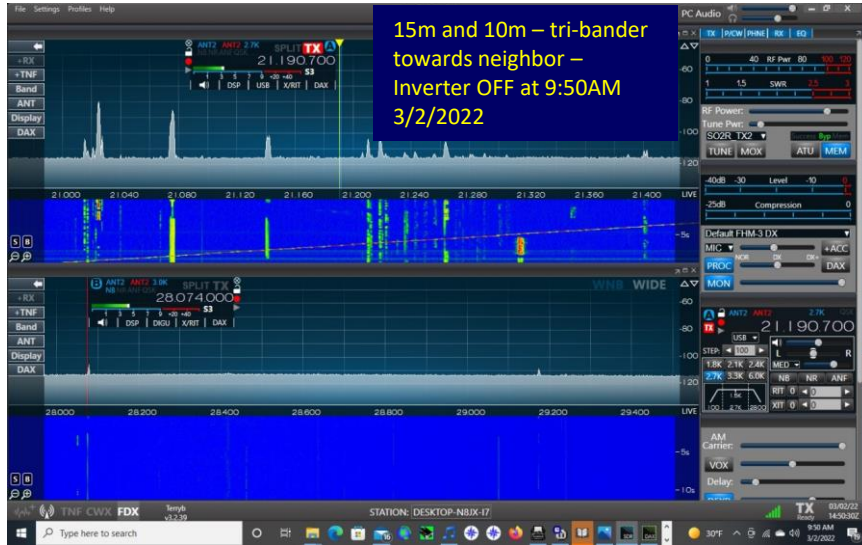
	<u>noise floor</u>	<u>noise spikes</u>
40m	-119	none
20m	-109	none

	<u>noise floor</u>	<u>noise spikes</u>
40m	-119	none
20m	-98	25 dB above noise floor, every 40 KHz with sidebands

- On 40m, noise floor remains the same – likely due to using 20/15/10m tri-bander on 40m
- On 20m, noise floor increases by 11 dB



15m and 10m

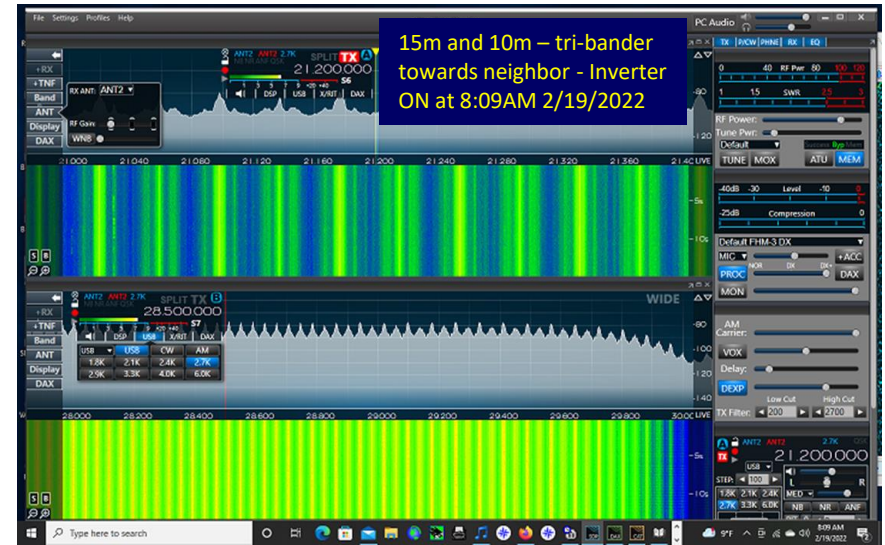


noise floor

noise spikes

15m -116, 20 KHz ripple
10m -113, 20 KHz ripple

none
none



noise floor

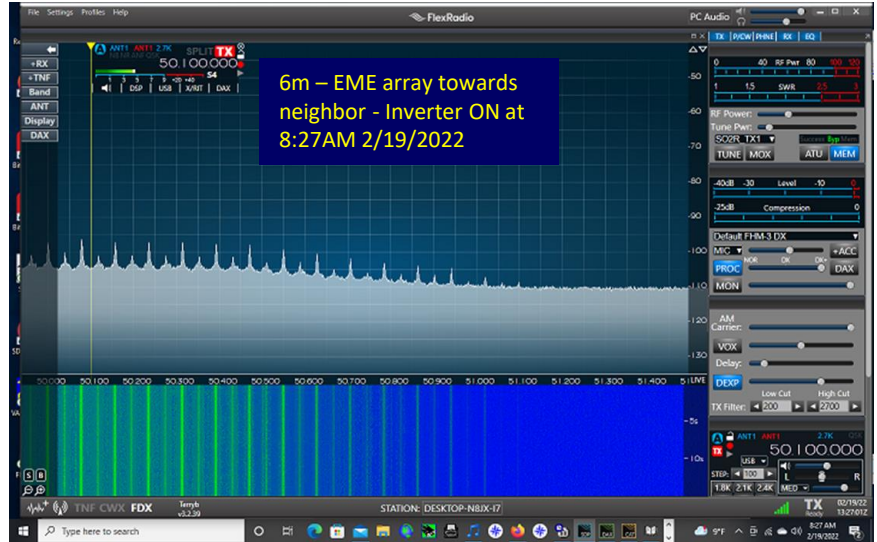
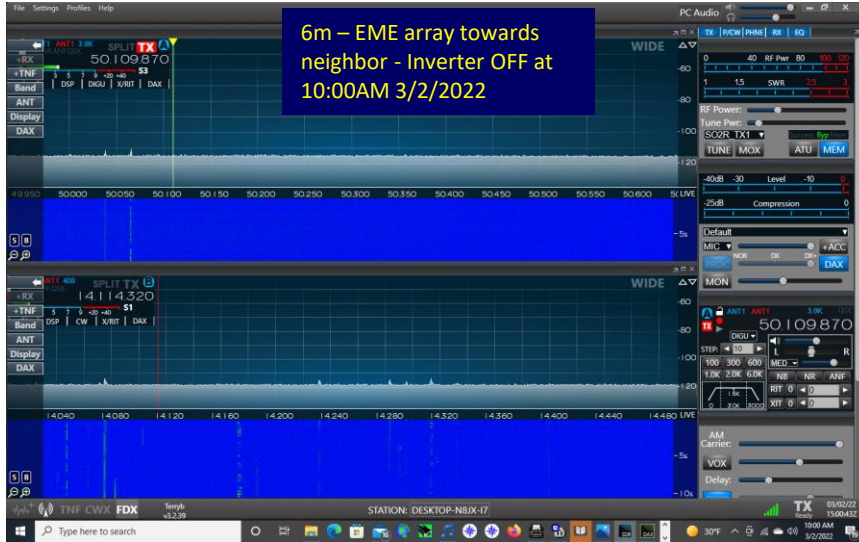
noise spikes

15m -100 20 dB above noise floor, every 40 KHz with sidebands
10m -90 10 dB above noise floor, every 40 KHz with sidebands

- On 15m, noise floor increases by 16 dB
- On 10m, noise floor increases by 23 dB



6m



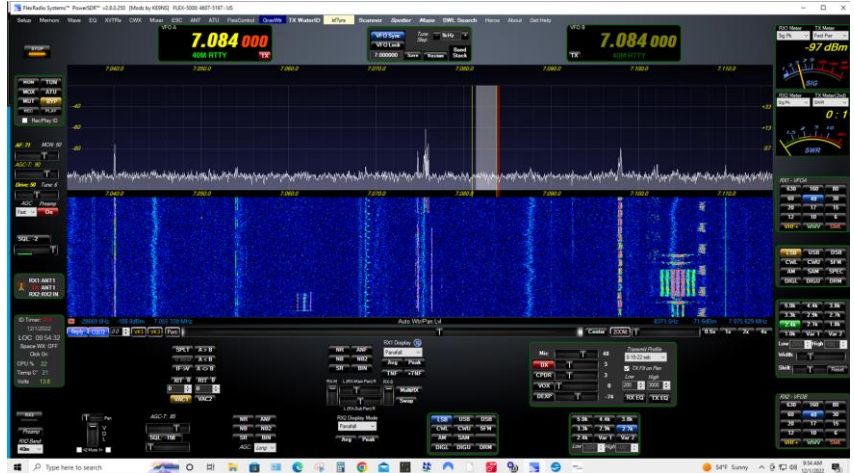
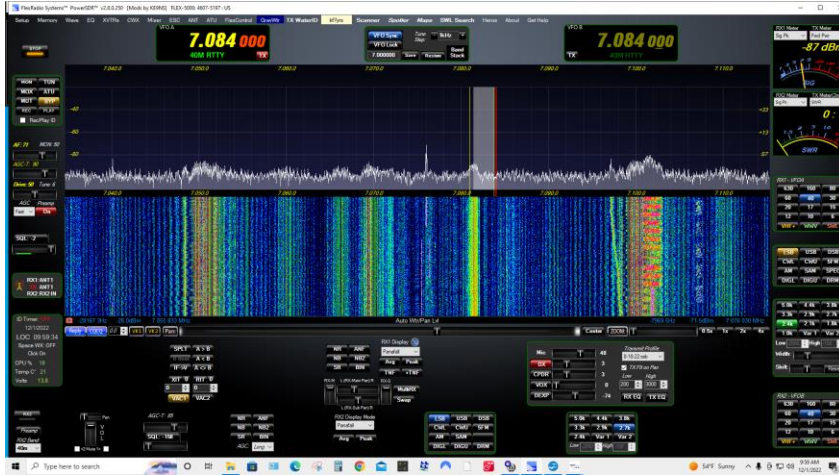
<u>spikes</u>	<u>noise floor</u>	<u>noise</u>	<u>noise floor</u>	<u>noise spikes</u>
6m	-115	none	6m -105	8 dB above noise floor, every 40 KHz

- On low end of 6m, noise floor increases by 10 dB
- Note that 6m EME array is 360 feet from the Inverter
- Also note that you can see the bandwidth of the 6m EME array



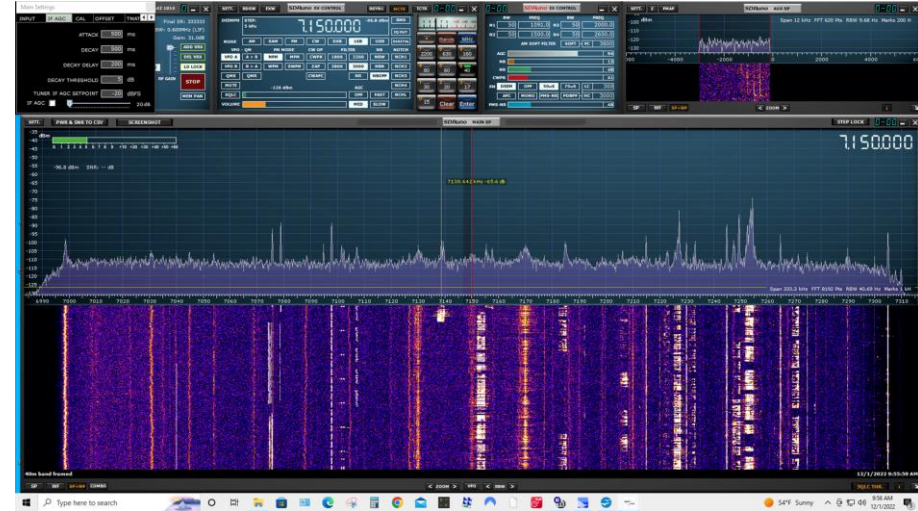
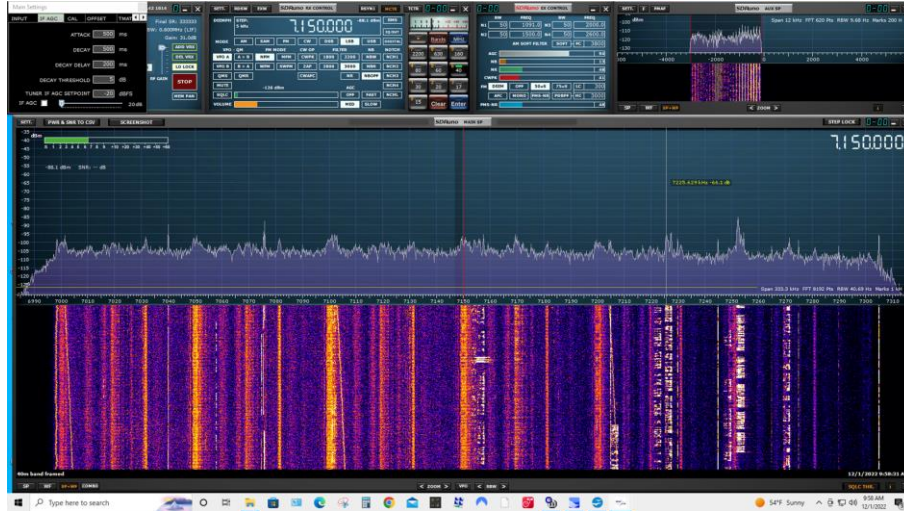
RFI Examples–SolarEdge (ham's system)

Flex 5000a, 40m band close up, inverter on/off



RFI Examples - SolarEdge

SDRPlay, 40m band close up, inverter on/off



RFI Examples – Enphase

- No substantive examples (maybe due to microinverter technology)
- One ham over the last year took some measurements



Vendor Actions

SolarEdge

- ARRL has a reliable, single point contact
- SolarEdge confirms the RFI is from their system and determines corrective action, the installers and/or SE may:
 - Redesign and replacing components
 - Add filtering
 - Incorporate twisted pair wiring between panels

Enphase & Generac

- ARRL has contacts at both if needed
- Both have said we should use their customer service/support system for RFI resolution

Vendor Advice

- We have asked vendors how they handle RFI generally
- All advise something similar to this Enphase statement:

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, you are encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help



Final Thoughts

ARRL Headquarters Role

- HQ keeps a solar [web page](#) & database to track status
- Teams should have the ham contact me at HQ to resolve these – encourage ham to gather data, such as:
 - Day/night or other on/off screenshots and/or video
 - Neighbor address & contact info (if its on a neighbor's home)
 - Installer information
- ARRL is considering an industry standard similar to one being developed for power line RFI
- Stephen Anderson, ARRL RFI Engineer contact info:

Email: w1emi@arrl.org

Phone: (860) 594-0392

