

Practical Challenges

Utility Interconnections for a Retrofit PV system

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Distributed Photovoltaic systems are gaining popularity in both residential and commercial/industrial markets. For new buildings with planned PV systems, the design engineer has flexibility in the PV interconnection that would allow meeting all the NEC code and local utility requirements. Electrical equipment manufacturers generally would not have any problem in providing the equipment per an engineer's design. However, for PV system installations that are retrofitted into existing buildings and existing power systems, the configuration of the existing electrical equipment could present many challenges that the designer will have to overcome. This can add significant cost and time delay to achieve a successful installation and startup. We will explore some of the potential challenges and possible solutions. The following discussion will focus primarily on commercial/industrial installations, as residential systems are generally smaller and less complex.

NEC 690.64 "Point of Connections" outlines all the relevant code that will have to be met when interconnecting a PV system to the utility service. The output of the PV system is allowed to be connected on either the supply side or the load side of the utility service disconnect.

New facility

For a new building with a planned PV system, the design engineer has different options to plan for the interconnection point. Line side interconnection is preferred for simplicity. Most manufacturers of switchboards can provide either a set of lug landing or an "Over Current Protective Device" after the utility meter but ahead of the main service disconnect. This will allow an easy field connection to the output of the PV system. If a load side connection is preferred, electrical equipment manufacturers should have no problem in providing the equipment that will meet the NEC code.

Retrofit-Supply side connection

For a retrofit PV system, the existing power system could provide additional challenges. It may be problematic to do a supply side connection for an existing building. But this would be the "preferred" connection if the main service disconnect or the ground fault relay is not suitable for back feed. The original equipment manufacturer of the service entrance switchboard typically does not

offer an UL listed kit to retrofit either a lug kit or over current protective device between the utility meter compartment and the main service disconnect. Usually the installation contractor will have to tap the bus ahead of the main device. The local AHJ should be consulted prior to doing this field modification. If the local AHJ allows this practice, the installing contractor/designer should make sure the following items are fully reviewed.

- 1) By drilling holes to mount cable lugs on the bus, it could reduce the ampacity of the bus itself.
- 2) Location of the lugs shall provide sufficient space to meet the NEC minimum wire bending space requirement.
- 3) Cables will have to be supported and braced to meet the short circuit current requirement
- 4) AHJ might require over current protection (located in the equipment where the tap is made) for the cables between the cable tap and the PV inverter/AC disconnect.
- 5) Last, the local AHJ might require a third party testing agency, e.g. UL, to perform a field inspection.

All of these items could add significant cost to the overall PV system installation.

Retrofit-Load side connection

Generally a load side connection is easier to implement for a retrofit system, though the following should be carefully reviewed.

1. During a sunny day with lightly loaded facility, it may be possible that the PV system will be generating excess power that would be fed back to the utility. NEC code requires the main device, if it is a breaker, be UL listed "suitable for back feed." Most of the solid-state breakers (with electronic trip) and non-interchangeable trip thermal magnetic breakers are suitable for back feed. If in doubt, the breaker manufacturer should be consulted. If the existing breaker is not suitable for back feed, the original equipment manufacturer should be consulted about possible a change out. Alternatively, a line side connection should be considered. In the event the main device is a fused switch, NEC 404.6.C "Exception" does allow fusible disconnect to be back fed.

If a Ground Fault relay is provided with the main device, NEC code requires that the GF protective device be **identified and listed as suitable for back feeding**. Since UL 489 and UL 508 standards on molded case breaker and industrial controls have no prescribed testing standard nor procedure on testing of GF for back feed, no manufacturer can claim their product is specifically UL listed for being "suitable for back feed". I believe the intent of this code is to prevent the use of GF device that would be damaged in the event that current is flowing backward. If the GF device is damaged, then it may not function under normal direction of

power flow. If in doubt, the breaker or relay manufacturer should be consulted. GE has performed factory testing of GE breakers with integral GF (including Spectra Series, Record Plus, Power Break, Power Break II, Entelliguard, WavePro series of breakers with electronic trip units) in back feed configuration and verified that they will not be damaged under such condition.

2. If a breaker is used as the dedicated branch device to connect to the PV inverter, it shall also be UL listed as suitable for reverse feed. The placement of this branch device should be at the opposite end of the main device to avoid overloading any portion of the panel/switchboard bus.
3. NEC 690.64.B2 stipulates the sum of the ampere ratings of over current devices in circuits supplying power to a bus bar or conductor shall not exceed 120 percent of the rating of the bus bar or conductor. In certain conditions, the normal incoming device can be de-rated to allow the addition of a PV system. Example: A PV system is planned to be connected to an existing switchboard rated 1000A with a 1000A main device and horizontal bus. 120% of the bus rating is 1200A. ($1000A \times 1.2 = 1200A$). Since the main device supplying power to the bus is 1000A, the PV branch device can only be 200A maximum ($1200A - 1000A$). If a larger PV system is planned, a new switchboard with larger bus will normally be required. If this facility is generally lightly loaded, it might be possible to reduce the size of the service disconnect to allow for the larger PV system. Using the previous example of 1000A service, if it is determined that the facility never exceeds 800A in power demand and has a solid state 1000A breaker, it may be possible to change the breaker rating plug to 800A thus reducing the maximum power that could be drawn from the utility. Then a 400A PV system can now be installed. ($1200A - 800A = 400A$).

The above scenarios are some of the common examples that one may come across. Consult your local GE Specification Engineer if you run into a situation that was not covered in this brief article or if you have any questions.