

LESSON

Interconnection and System Commissioning

BIG IDEA(S)

Interconnection standards dictate how renewable energy systems can be legally connected to the electricity grid. They are a set of requirements and procedures for both utilities and customers.

OBJECTIVES

Students will:

- Explain the interconnection process at the site to utility.
- Explain the interconnection application for your local jurisdiction.
- Interpret line drawings distinguishing load-side and line-side interconnection scheme.
- Explain the purpose of system commissioning.

TASK LIST SUBCATEGORY

- 505 Install racking, modules, inverter, BOS, conduit, interconnection
- 508 Identify the fundamentals of system commissioning

OVERVIEW

The majority of US residential and commercial PV systems are *grid-interactive (or grid-tied)*, which means that they are designed to be able to export excess power to the utility grid. Export occurs when the power generated by the solar system is greater than the power used by the loads on site. A photovoltaic system will be given permission to interact with the power grid only after a formal approval has been issued by the utility. The process through which a utility verifies a solar system's compliance to its technical and administrative requirements is commonly referred to as the interconnection process. There are two main types of PV interconnection: Load-Side and Line-Side.

FURTHER DEFINITION OF KEY TERMS

A **busbar** is a rigid conductor used for connecting together several circuits. The system for monitoring partial discharge is connected in parallel with a busbar between a generator and an electric network. A busbar is a metal strip in a distribution box that provides one connection point for all the circuits.

Commissioning is the process of assuring that all systems and components of a PV plant are designed, installed, tested, operated, and maintained according to the operational requirements of the project's owner or final client. To ensure building code compliance, an inspection will verify proper material selection, soundness of structural support, and secure attachment to the roof or ground. Inspection of a solar PV installation's electrical system often focuses on wiring methods, circuit protection, grounding, and safety signage.



STANDARDS

PA

3.4.10.A1. Illustrate how the development of **technologies** is often driven by profit and an economic market.

3.4.10.A2. Interpret how **systems** thinking applies logic and creativity appropriately in complex real-life problems.

3.4.10.B2. Demonstrate how humans devise **technologies** to reduce the negative consequences of other **technologies**.

3.4.12.B2. Illustrate how, with the aid of **technology**, various aspects of the environment can be monitored to provide information for decision making.

3.4.12.C2. Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

ETS1.B: Developing Possible Solutions: When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HS-ESS3-2),(secondary HS-ESS3-4)

INSTRUCTIONAL

TEXTS/REFERENCES

[PV Interconnection: Load-Side vs. Line-Side](#)

Solar Electric Handbook, SEI, 2013. P 27

IMPLEMENTATION (LESSON PLAN)

ENGAGE/EXPLORE

- Using the Lab electric wall set-up, have students share how connection to/from the utility works. How would this take place safely? Who do you think has jurisdiction to permit this connection in your town/city?

EXPLAIN

1. General Standards for interconnection: Although interconnection standards are not consistent across states and utilities, many states adopt engineering and safety requirements based on IEEE 1547 and UL 1741 standards. Additionally, state interconnection standards are increasingly modeled after FERC's SGIP (see Background section above). Interconnection standards can also vary by:
 - a. Net metered vs. non-net metered systems
 - b. System capacity requirements
 - c. Eligible technologies
 - d. Eligible sectors (e.g., commercial, residential)
 - e. Fees
 - f. Insurance requirements.
2. Review the PECO brochure for the interconnection process and the steps involved. [PECO Interconnection Brochure](#)
3. Is there another licensing entity that needs to be involved in your area? How is an agreement handled?



IMPLEMENTATION (LESSON PLAN) - CONTINUED

EXTEND/DEMONSTRATE: Doing the Interconnection

4. There are **2 types of residential solar interconnections** (otherwise known as the point-of-interconnection, POI). Line/Supply side and load side. The type of interconnection is determined by where the solar is meeting the grid.
 - a. If a backfeed breaker is installed then that breaker is on the **load-side** of the main service disconnect and thus is a load side connection. **Load-side tap connection** is applied when there are no circuit breaker slots available. The wires are connected directly to the existing wires, between the electrical panel and (on the *load side* of) the main breaker.
 - b. If the solar power is joining the grid between the main service disconnect and the utility meter then it is a **line/supply side connection** because it is on the line/supply side of the main service disconnect. This method requires that the wires from the inverter are connected to the service wires on the line side of the circuit breaker. Utilities usually require that the design for this connection and the installation are approved by a professional electrician.
 - c. Once the utility engineers have approved the line side tap connection, it is necessary that a transformer power shutdown is scheduled, to allow the electrical contractor to perform the connection on wires that are otherwise connected to the utility grid.
5. Feedback Breakers
 - a. The NEC 120% rule: How big of a backfeed breaker are you allowed to insert into the main service panel in the house? This is where the 120% rule applies. Here are the basics, take the rating of the bus bar and multiply it by 120% (1.2). Then subtract the size of the main service disconnect and that will result in the size of the largest backfeed breaker that can be installed in a main service panel. Sample calculation:
 - i. Busbar rating 200A
 - ii. Main service disconnect 200A
 - iii. Calculation: busbar = $200A \times 120\% (1.2) = 240$, $240 - 200$ (Main service disconnect) = 40. So a 40 amp breaker is the largest backfeed breaker that can be installed.
 - iv. Remember, a backfeed breaker must be installed on the opposite end of the bus bar from the main service disconnect.
 - b. The overcurrent protection devices below are the main circuit breaker and the PV backfeed circuit breaker in the electrical panel.

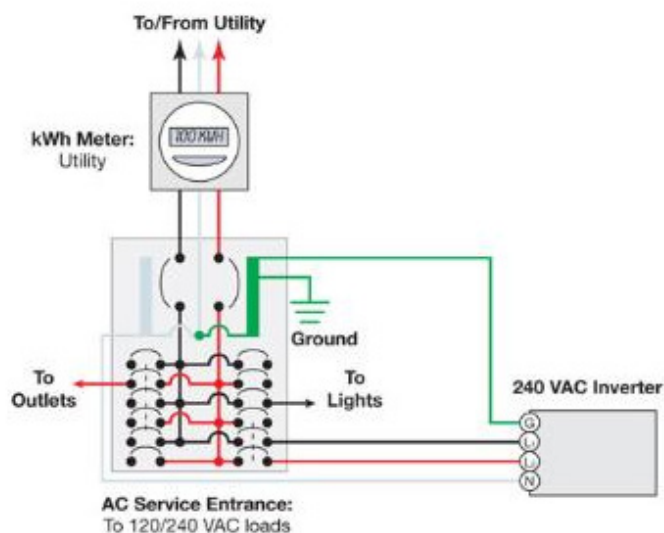


Image courtesy of Home Power Magazine

IMPLEMENTATION (LESSON PLAN) - CONTINUED

- c. The overcurrent protection device is the PV *fused* AC disconnect.

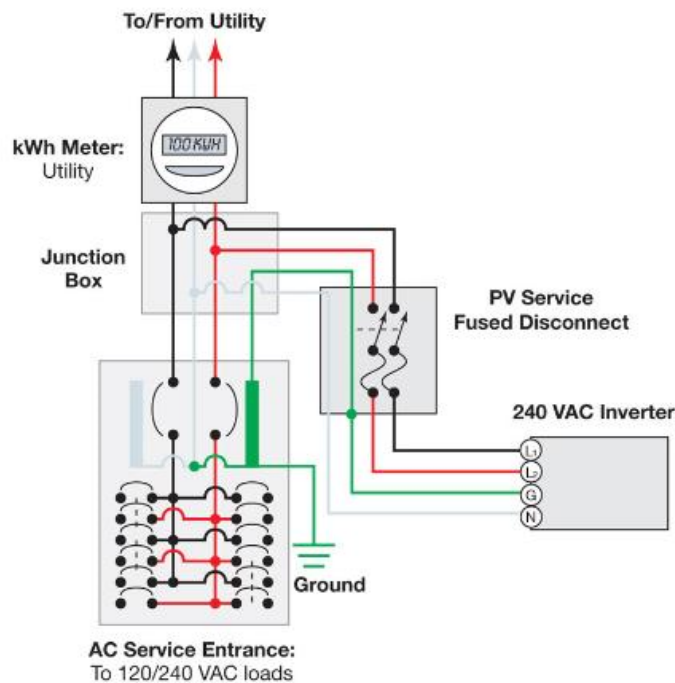


Image courtesy
of Home Power
Magazine

6. Interconnection and Utility Companies

- a. During the interconnection process, utilities certify that a PV system meets the following general requirements:
 - i. The power exported to the grid is measurable and compliant with the grid's standards in terms of voltage, frequency, power quality. that the equipment used is certified
 - ii. The AC side of the PV system (between the inverter and the utility meter) meets the utility's safety requirements (labeling, location of equipment, connection to electric panel)
 - iii. The power and energy generated to meet the net metering program requirements
- b. Utilities usually require that an interconnection application is submitted to their interconnection department to gather the necessary information about the proposed system, The application may be submitted by the account holder or, when properly designated, by the contractor that designs and installs the PV system. The interconnection application usually includes professional technical drawings, such as site plans and an electrical diagram.
- c. Once the utility has received the approved final permit, it will schedule an inspection of the installed system. During the site visit, performed by qualified utility personnel, the solar system will be tested, and, if necessary, revenue meters installed and/or replaced. When the system is approved, the utility will notify the account holder and the installer, which will then be able to turn on the system and export power to the utility grid.

EVALUATE

- Have working groups provide an oral demonstration at the power wall to walk through the actual interconnection process.

