

## Bi-Directional Metering for Residential Solar Energy Systems

### Introduction

Solar panels generate energy to power a building's electrical systems. In most cases, builders acknowledge that the solar panels installed on the roof will not always be sufficient for the building's electrical needs, so the building is also connected to the main utility grid. However, sometimes the solar panels might generate surplus power beyond the needs of the building. At these times, the surplus power is exported into the main utility grid. Most utility companies offer credits to buildings that export power in this manner.

An E51 energy meter capable of bi-directional metering is important in this application. The meter monitors power imported from the grid, as well as power exported from the solar panels. In this way, a facility administrator can keep track of all energy data, ensuring accuracy in billing and crediting.

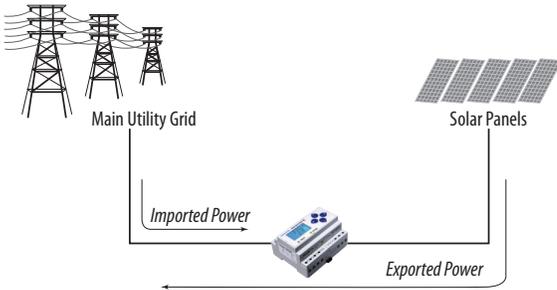


Figure 1: Imported and Exported Power

### Monitoring Applications

In a residential electrical system, the E51 meter is used to calculate power generated and power imported (Figure 2).

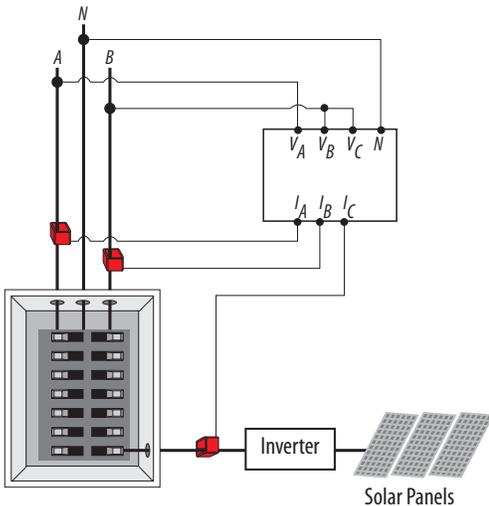


Figure 2: A typical 120V/240V split-phase installation

To calculate net power in this application, first set the system type in register 130 to a value of 40. Then measure the current (I) and voltage (V) as shown. Assuming a power factor of 1, calculate the power values:

$$P_A = V_A \times I_A \times PF$$

$$P_B = V_B \times I_B \times PF$$

$$P_C = V_C \times I_C \times PF$$

$$\text{Total imported power} = P_A + P_B$$

$$\text{Total exported power} = P_C$$

$$\text{Net Power} = \text{Total imported power} - \text{Total exported power} = (P_A + P_B) - P_C$$

The E51 also monitors power in a single-phase residential system.

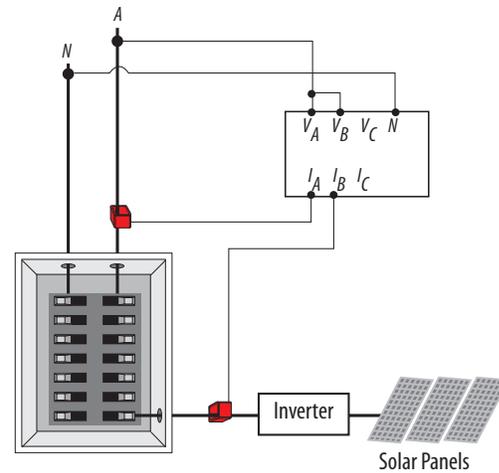


Figure 3: A typical 120V single-phase installation

In this example, set the system type in register 130 to a value of 12. Assuming a power factor of 1, calculate net power:

$$P_A = V_A \times I_A \times PF$$

$$P_B = V_B \times I_B \times PF$$

$$\text{Total imported power} = P_A$$

$$\text{Total exported power} = P_B$$

$$\text{Net Power} = \text{Total imported power} - \text{Total exported power} = P_A - P_B$$

## CT Scaling

These calculations assume that all CTs are the same size (e.g. 125 Amp or 200 Amp CTs on the conductors for the mains and inverter), because the meter contains only one register for programming CT value. If different sized CTs must be used in an installation, the software can be programmed to compensate.

For example, in Figure 2, if 200 Amp CTs are used to measure  $I_A$  and  $I_B$ , and a 50 Amp CT used for  $I_C$ , then set the CT value at 200 Amp, using either the E51 display or by setting register 131. Next, since  $200A \div 50A = 4$ , program the software to divide the  $I_C$  value by 4 before calculating  $P_C$ .

This scaling factor must also be applied to other C-phase values:

Real Power, kW

Reactive Power, kVAR

Apparent Power, kVA

Current, Amp

## Summary Registers

In the installations illustrated in Figures 2 and 3, summary values of all three phases are invalid. The registers will still contain data, but the data assumes that the CTs are reading energy in all three phases (A, B, and N), so the information is not correct for split-phase and single-phase installations. Summary values include:

Real Energy, kWh

Reactive Energy, kVARh

Apparent Energy, kVAh

## Accuracy in Renewable Energy Systems

If a facility incorporates a renewable energy system, it is important to ensure accurate metering. This is easy to accomplish with a bidirectional E51 power and energy meter. A facility administrator can conveniently calculate all power usage from both the utility and the on-site system, verifying accuracy in utility bills and credits. This helps to quantify the total savings achieved by the on-site system.