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SOLUTIONS FOR DEPLOYING PV SYSTEMS IN NEW YORK CITY'S SECONDARY NETWORK SYSTEM

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http://www.nrel.gov/docs/fy10osti/49789.pdf

New York City has set a goal to increase its installed PV capacity from 1.1 MW in 2005 to 8.1 MW by 2015. A key barrier to reaching this goal, however, is the complexity of the interconnection process on secondary network distribution systems (networks).

Networks use coordination and protection schemes that are based on the assumption that power flows in one direction—from the utility distribution system to the customer point of interconnection. With traditional power plants, this is true. When power sources like PV are connected to the distribution system at the utility customer's site, however, power has the potential to flow in the opposite direction—from the customer toward the utility distribution system. This reverse power flow has the potential to disrupt network protection schemes and threaten network reliability.

NETWORK POWER FLOW CONSIDERATIONS

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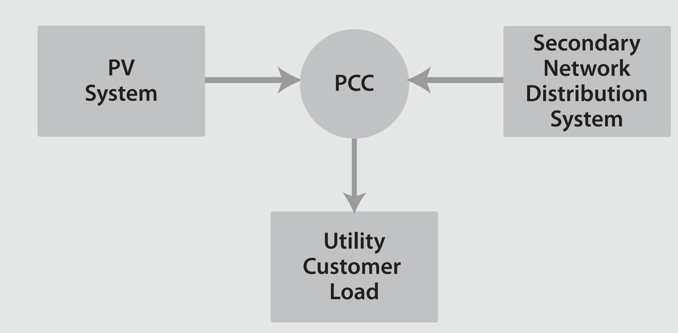
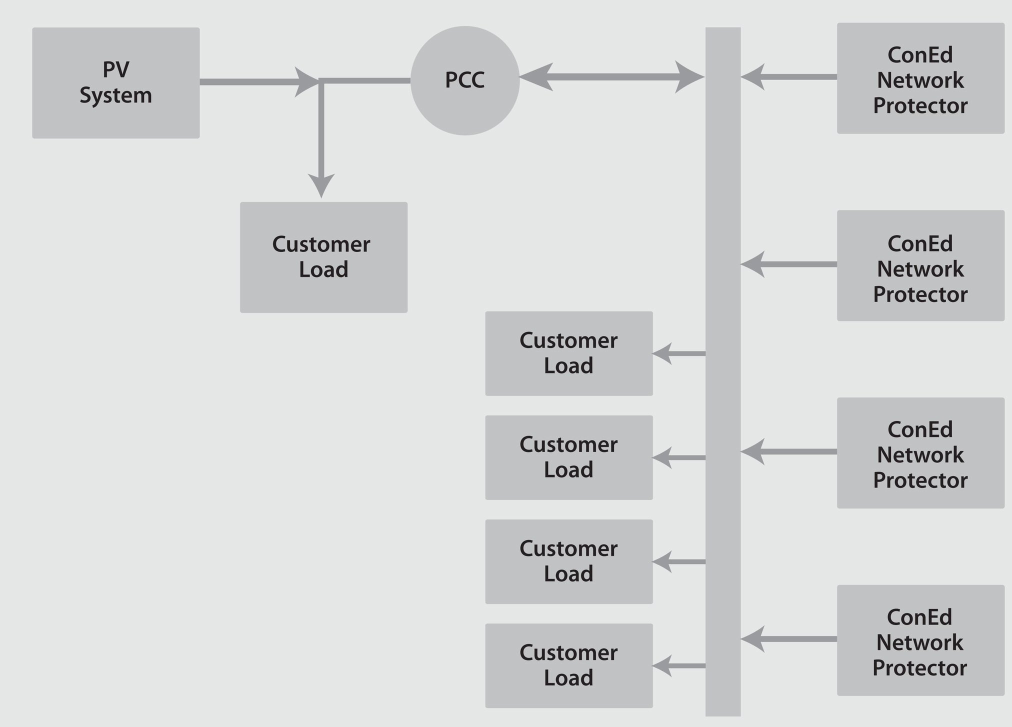
NETWORK PROTECTORS

A unique feature of a secondary network distribution system, compared to a radial distribution system, is the addition of the network protector (NP). The NP is a relay and breaker pair that senses reverse-current flow toward the utility and is designed to prevent current from flowing back toward the utility system or to ensure the given transformer disconnects from its low-voltage side. This is an important design feature that ensures reliability and continuous operation in the event one or more feeders are lost due to a device failure or when the electric utility has planned maintenance activities.

Block diagram of a non-exporting system



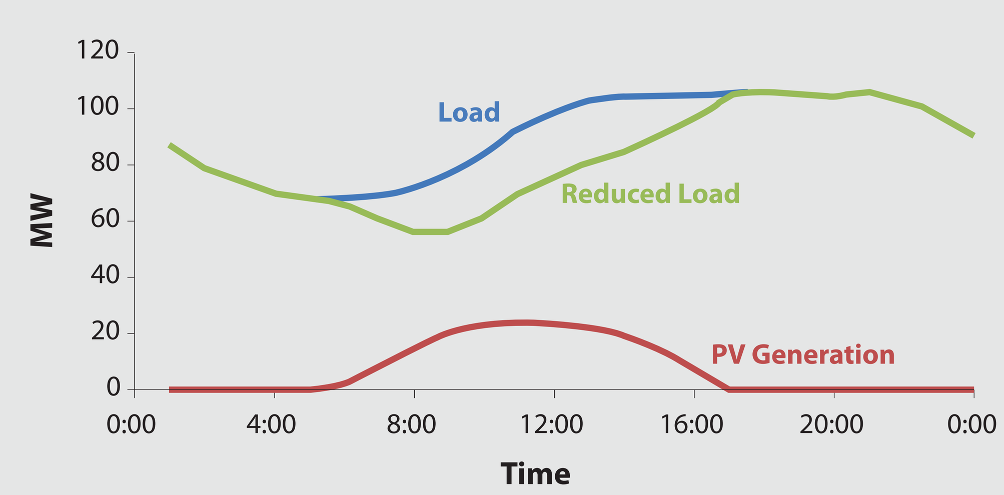
Power flow within a secondary grid network that contains utility customers with PV systems.



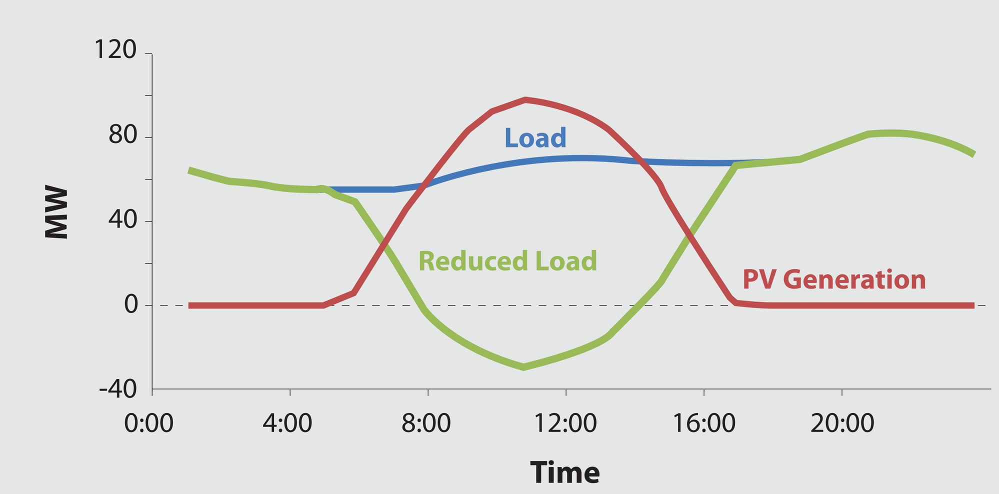
HIGH PENETRATION PV CONSIDERATIONS

NREL worked with Con Edison through the DOE Solar America Cities partnership program to evaluate the maximum PV deployment capability in several areas served by secondary networks in New York City. While many areas within New York City had significantly greater daytime loads than full PV deployment, some areas were found to have significantly less daytime load than full PV deployment (based on actual Con Edison network load profiles compared to PV generation calculations).

Cooper Network maximum export day



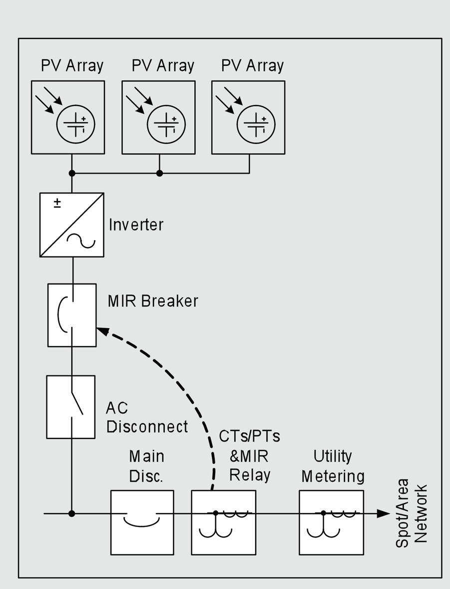
Fox Hill Network maximum export day



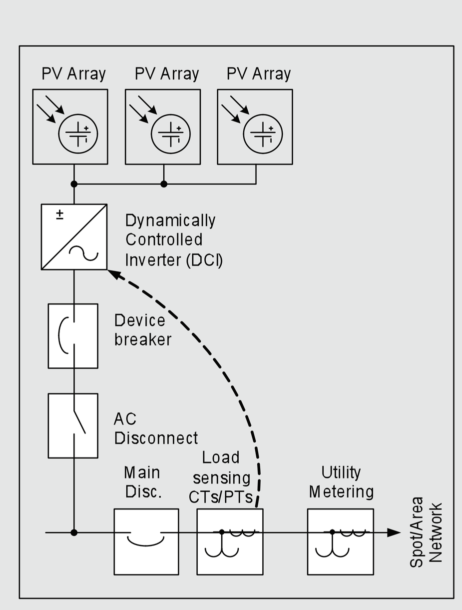
MAINTAINING NETWORK RELIABILITY – CONCERNS AND SOLUTIONS

FOCUS ON FOUR KEY SOLUTIONS

1. **Minimum Load** – Evaluate 12 to 24 months of daytime load demand data for the site under consideration and size the PV system so that it will not produce more energy than the facility consumes at any instant in time.
2. **Reverse Power Relay (RPR)** – If there is a possibility that the PV system might export power to the utility, and that is unacceptable, then an RPR may be installed to disable the PV system in case of a backfeed situation. Some utilities require an RPR, as well as other methods, to insure the PV systems do not backfeed into the network. This system is a simple approach to ensuring zero backfeed and is based on real-time monitoring.
3. **Minimum Import Relay (MIR)** – Similar to the RPR, the MIR may be installed to disable the PV system in case of a backfeed situation. However, the MIR is typically set at a threshold above zero current, as the RPR is typically set, and will disable the inverter once power flow into the customer meter drops below a predetermined level.
4. **Dynamic Controlled Inverter system (DCI)** – At least one inverter manufacturer is offering an option for a dynamic controlled inverter which, unlike the RPR, ramps down the power level of the inverter if the energy being consumed at the site drops below a specific level. The energy flow is monitored at the main disconnect (or at the utility revenue meter) and a control signal is sent to the inverter(s) which effects a reduction of output if required. This type of inverter system may be the most cost-effective and logical approach of all options being considered at this time.



A one-line example of the sensing and control used for a typical MIR system. The MIR relay and breaker arrangement are nearly identical to an RPR system. While an MIR relay would be set at an agreed upon value between system owner and the utility company, an RPR would be set at a low-level of reverse power close to zero amps.



DCI system which senses the building load and can control the output of the PV system.

SYSTEM INTEGRATION CONSIDERATIONS

As the number of PV systems in the New York City area increase in number and size, the following issues will grow in importance:

PV systems that are non-exporting will be the least problematic for the electric utility. Non-exporting PV systems should be moved to a fast-track in permitting and approval as the level of studies and controls should be minimal.

There are several means to insure that a system is non-exporting, and those include;

- Reverse power relay installation
- Dynamically controlled inverter
- Minimum customer load greater than peak PV generation
- Energy storage

PV systems tied to spot networks must be non-exporting, and the load at the spot network PCC should be greater than zero.

PV systems that are exporting must have a higher level of attention given to them when the utility evaluates or studies the application.

Monitoring, information exchange, and control systems will need to be expanded and will be critical for the utility in order to meet their obligation to serve electric loads.

A concerted effort will be required to model the response of secondary networks with a high level of PV system deployment in order to understand system limitations.

Smart grid technologies will become the essential tool for the utility system as more PV systems, and other DG systems, come online.

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