Case Study: Colorado Convention Center – Denver, Colorado

Key Highlights

System Owner:	City and County of Denver
Utility:	Xcel Energy
System Integrator:	Namasté Solar; Boulder, Colorado
System Size:	300 kWp (DC)
Network Type:	Spot Network (Eight spot networks, PV system into one)
Special Interconnection Requirements:	Minimum import relay Dynamically Controlled Inverters (3) Minimum Load greater than PV generation

Figure 15. Colorado Convention Center PV System

Introduction

The Colorado Convention Center is located at 700 14th Street in Denver and has almost 600,000 square feet of meeting space. Namasté Solar, of Boulder, Colorado, was chosen to do the system layout and installation of the PV system. The three inverters were custom-designed for the center and have a dynamic control on each. The overall PV system design uses three different methods to ensure no backfeed occurs onto the network.

System Overview

PV System Description. The PV array is located on the southern side of the rather large Colorado Convention Center roof, and was installed in 2008 (Figure 15 and Figure 16). The layout and installation of the PV array was completed by Namasté Solar, and is mounted using a system that does not require roof penetrations. There are three SatCon inverters (each three-phase) that are connected to the AC disconnect switch adjacent to the service disconnect. The SatCon inverters are all controlled using an innovative "dynamic controlled inverter" system which reduces energy output from the inverters at times when the convention center may not be able to consume the energy. This dynamic control system is one of three methods used to eliminate power backfeed into the spot network. The Namaste engineer and utility representative verified that the load on this spot network was more than 350 kW during daytime hours using five years of recorded data. The PV system also employs a minimum import relay in the event the dynamic controlled inverters fail to function properly. The PV system is estimated to produce 479,000 kWh during the year.

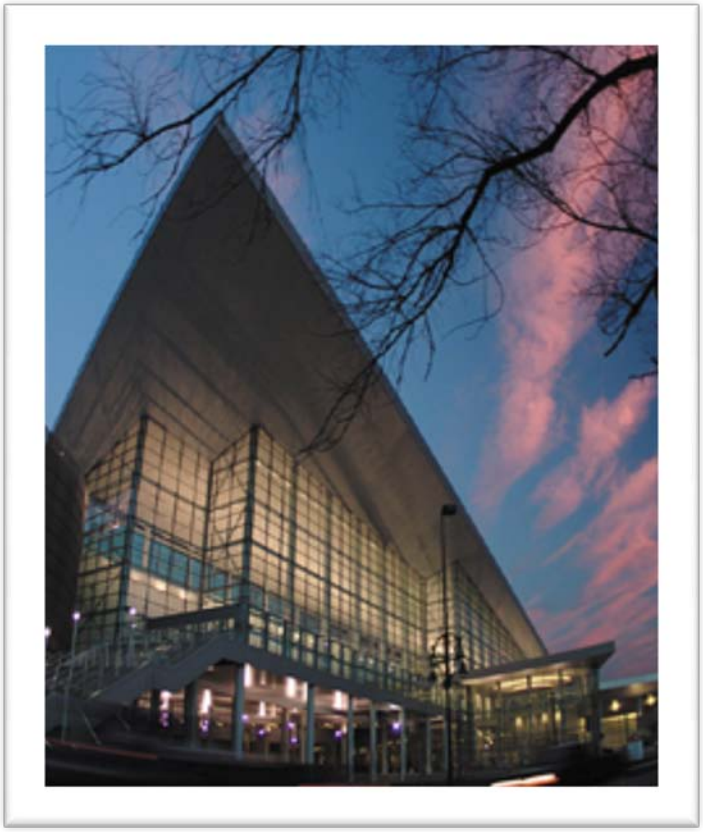

Figure 16. Colorado Convention Center

The convention center expanded over the last five years, and there are older sections of the roof that were designed only for snow load and for display load (hanging from the ceiling below the roof) and will not accommodate additional PV arrays. The system is

rated at 300 kWp DC.[6] The load on the other spot networks is minimal when the facility is not in use.

Network Description. The Colorado Convention Center was built in two phases. Phase I required five spot networks located on the east side of the complex. Phase II consisted of a separate mirror image complex built later, which was independent of the Phase I complex. An additional five spot networks were required to serve the Phase II electrical forecasted peak load demands.

The spot network supplies all parking lighting, emergency circuits, and fire systems, as well as various other loads. That spot network was chosen because its minimum load exceeded the PV system maximum output, which makes it an ideal spot network for PV system interconnection. The network is a three-feeder, 13.2 kV to 480 volt, with three 750 kVA network transformers. The network protectors are not monitored electronically, but are checked periodically.

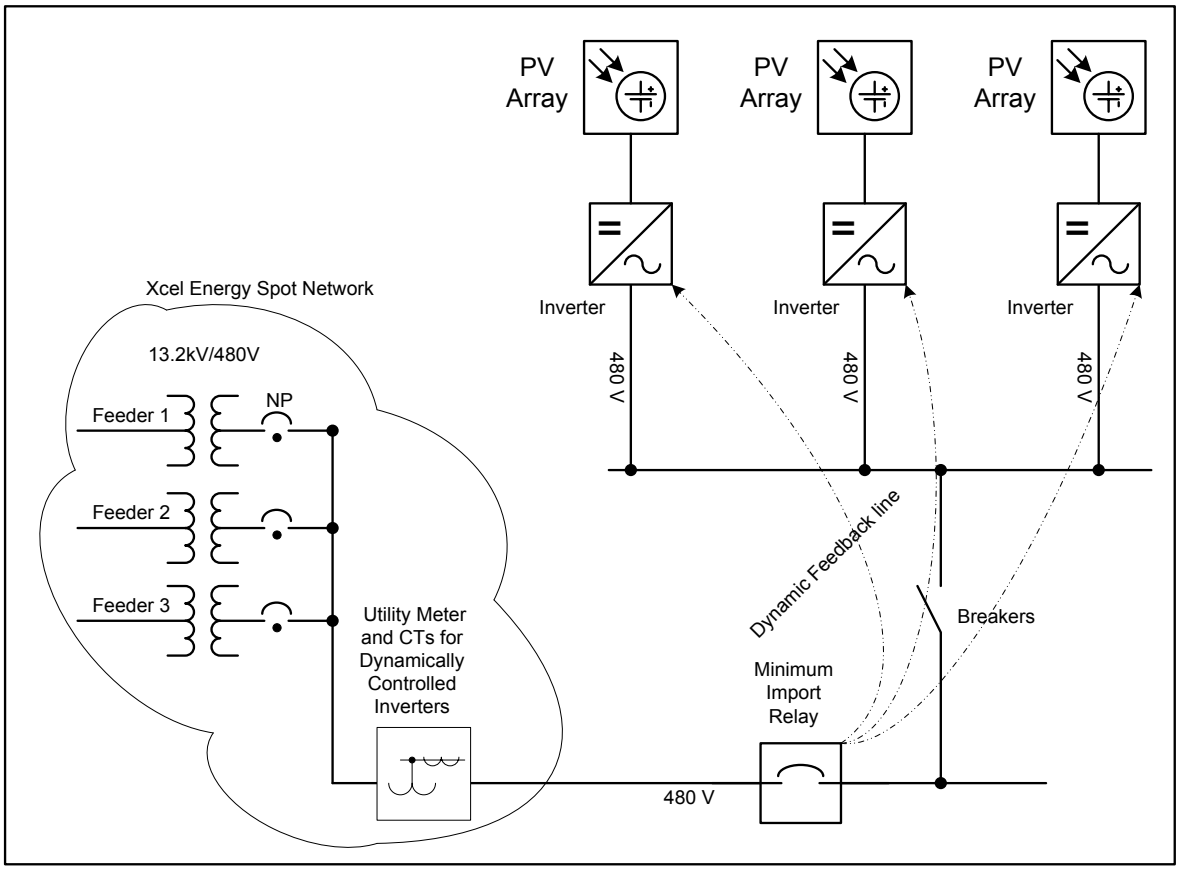

Figure 17. Simplified Electrical One-Line Diagram for the Colorado Convention Center

6 This is based on NREL data using the IMBY simulation program found at http://www.nrel.gov/eis/imby/.

Evaluation

The Colorado Convention Center PV system is considered a large-size PV system by Xcel Energy, and generates approximately 480,000 kWh of energy per year. The minimum load demand for the building, during daytime hours, is significantly higher than the AC power output of the system. The system is very new, but has had no operational problems since installation in the second-half of 2008. The system was designed with dynamic-controlled inverters, which govern the energy produced by the PV system and will reduce output if the power coming through the meter drops below 50 kW. The 50 kW was chosen to ensure no additional network protector cycling would occur due to system unbalance and to accommodate the loss of any one branch load without tripping the PV system or risking network separation. To add another level of redundancy, the system employs a minimum import relay, which will open the service if any power flows back toward the network protectors.

Utility Perspective

Xcel Energy required multiple and independent methods to assure themselves that the Colorado Convention Center PV system would not export power into the spot network or jeopardize the reliability of the power delivered to this high profile load. The specific requirements were worked out between Xcel Energy, the customer, and the system integrator to ensure the operational, safety, and reliability needs of all parties were met. The Xcel network engineering team will monitor this PV system and spot network to validate there are no interconnection problems.

Conclusion

The system has been operating within design parameters and has caused no known adverse situation for the customer and Xcel Energy. All energy produced by the PV system is consumed on site.