WHITE PAPER

How to Derive the Maximum Benefit From Solar Energy by Using IIoT-Enabled Energy Storage Systems

Chaoyen Wu
Product Manager

MOXA®

Abstract

In the renewable energy market, the solar power segment has traditionally been held back because of the high cost of solar power generation. Recent technological advancements in the solar energy field have drastically brought down the cost of power generation, thereby lowering the price of solar power, and leading to increased consumption of solar power. In addition, solar power is a clean source of renewable energy. Energy storage systems provide a means to align the solar power supply with the demand for power by storing excess energy at the most convenient or cost-effective times, and releasing power to critical power loads when required, thereby increasing efficiency and reducing wastage. The addition of energy storage systems to traditional solar power generation systems can take the solar power industry to the next level and help bolster growth in emerging solar markets. In order to do this, energy storage systems need efficient, reliable, and maintainable energy data management systems that are IIoT-enabled. However, most data-management solutions that exist today are designed for information technology (IT) applications. System integrators (SIs) looking to deploy Industrial IoT solutions in power applications are often faced with complicated requirement specifications. SIs often have to spend a lot of time customizing existing solutions to suit the requirements of automated energy management.

In this white paper, we look at some of the key trends in the renewable energy market and discuss how the residential solar power market can benefit from several new technological advancements in this field.

Released on October 31, 2017

Moxa is a leading provider of edge connectivity, industrial networking, and network infrastructure solutions for enabling connectivity for the Industrial Internet of Things. With over 30 years of industry experience, Moxa has connected more than 50 million devices worldwide and has a distribution and service network that reaches customers in more than 70 countries. Moxa delivers lasting business value by empowering industry with reliable networks and sincere service for industrial communications infrastructures. Information about Moxa's solutions is available at www.moxa.com.

How to contact Moxa
Tel: 1-714-528-6777
Fax: 1-714-528-6778

MOXA®
Reliable Networks ▲ Sincere Service

The Power Trend

The replacement of fossil energy sources by renewables is expected to accelerate due to the rapid reduction in the consumer cost of electricity from solar and wind sources. As per this news article, "[r]enewable energy capacity around the world was boosted by a record amount in 2016 and delivered at a markedly lower cost, according to new global data – although the total financial investment in renewables actually fell." The REN21 report referenced in this news article talks about a record increase in investment in the solar photovoltaics (solar PV) market for 2015, as well as a record increase in new production capacity in the same year. In addition, new production capacity in the solar PV market increased by 228 GW in 2015 and 303 GW in 2016. Energy producers now have excess solar power that they can supply to utility companies, and private households and companies are a key part of this new market structure. Power grids around the world are being modified to facilitate decentralized power generation to provide utility companies the flexibility they need to source power from external sources. This enables the utilities to efficiently absorb the excess power from energy producers, thereby making it easier to meet the continuing steep rise in the demand for power.

Residential Solar Power Generation

The search for sustainable and cheaper alternatives to the conventional power supply has seen the emergence of solar power as a preferred energy source. The benefits of using solar energy include a clean sustainable source of energy, low setup costs, low space requirements, and silent operation. Given these benefits, it should not come as a surprise that residential solar power generation is a rising trend in the renewable energy market. The two most common architectures seen in residential solar energy generation systems are described below:

The Conventional Architecture for Residential Solar Power Generation Systems

In conventional residential solar power systems, energy producers connect their systems to the main electricity grid. This type of setup allows the energy producer to feed excess energy into the main electricity grid and be financially rewarded for it by the energy companies. This is the most common type of installation.

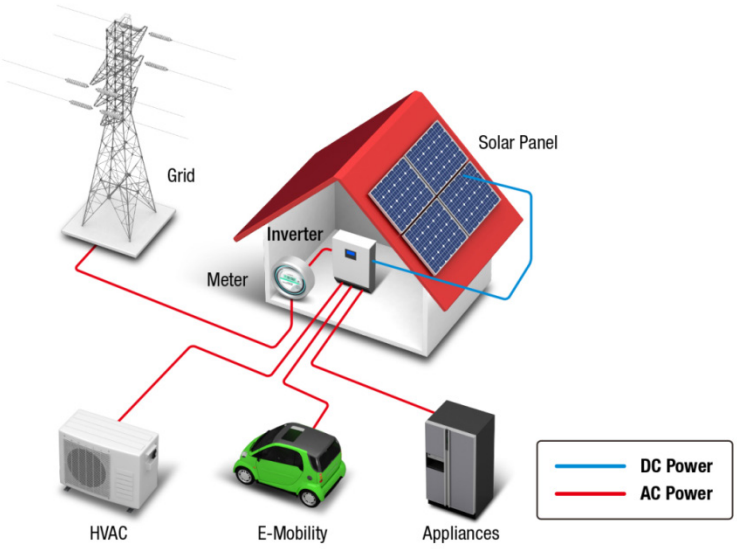

Figure 1: Conventional Architecture of a Residential Solar Power Generation System

Residential Solar Power Systems with ESS

The other type of residential solar power generation system is a 'stand-alone' solar power system. This type of system is found in remote properties where the cost of connecting the solar power panels to the main grid is prohibitive. The power generated is used to charge a battery bank, which in turn powers the local facility.

You can also find a "hybrid" system where the solar power system is connected to the main grid and in addition, a battery bank is used to store excess power.

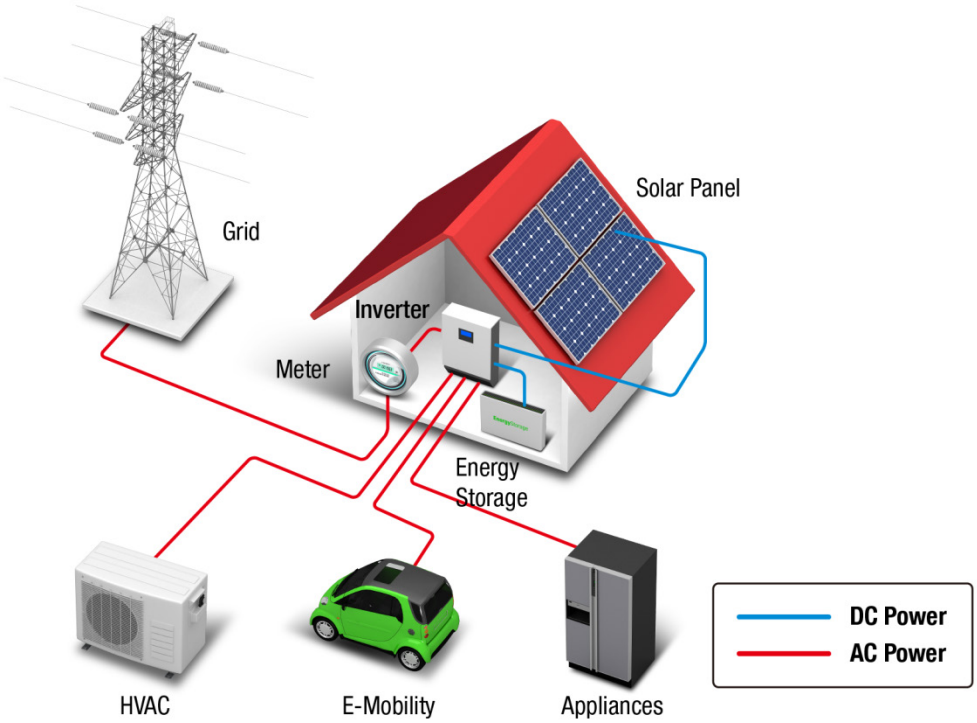

Figure 2: Residential Hybrid Solar Power Architecture with ESS

Optimizing Energy Costs Across Different Sectors

The complexity of energy distribution has increased because of the emergence of multiple storage and distribution systems, such as HVAC, E-mobility, and load management.

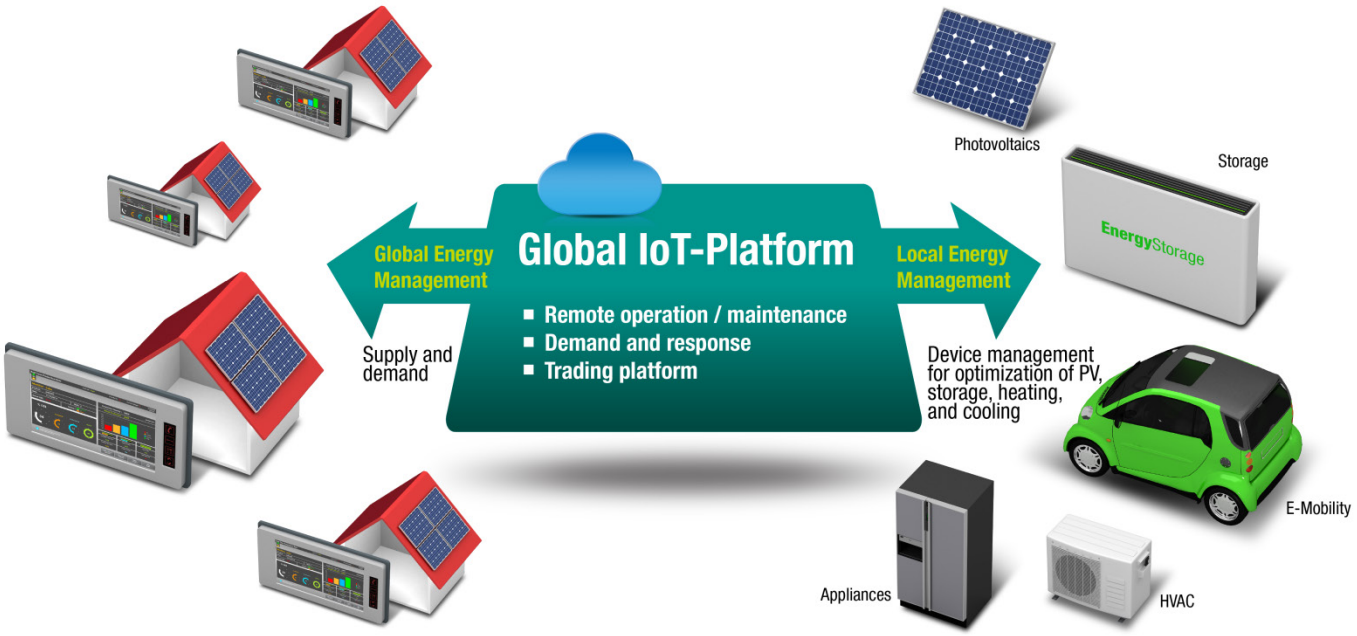

Figure 3: An IIoT-Platform Optimizes Energy Costs Across all Sectors

Matching supply with demand across different sectors is critical for reducing overall energy costs. An open IoT architecture can provide the flexibility that energy producers need to efficiently manage energy distribution across various power sectors while keeping costs down. The IoT facilitates automated energy management and makes decentralized control of energy management systems possible.

Deploying an IoT-platform in a solar power system can provide several benefits to energy producers and utility companies:

- Sophisticated visualization tools and data analytics to efficiently manage power demand and to intelligently distribute the available energy supply
- Various tools to optimize energy supply by managing local consumption and production
- Ability to store excess energy in energy storage systems and generate additional revenue by selling excess energy

Challenges in Residential Solar Power Generation

Device Management in Distributed Energy Systems

Centralized device management in a residential solar system is a challenge. Residential solar power systems are often located in remote areas and present many operational and maintenance challenges such as remote configuration, troubleshooting, and firmware upgrades.

Building local intelligence in power devices on a remote site can address the information needs in a distributed system and can help identify additional capacity on the grid. Leveraging IIoT technology to automate local actions and to create local intelligence will increase operational efficiency and lower costs. For example, solar power operators can build local intelligence into inverters that are used to control and manage their solar power devices.

Remote monitoring systems need a reliable Internet connection, failing which establishing a communication infrastructure will be a major challenge. One way to deal with this problem is to equip remote residential sites with multiple networking interfaces, such as Wi-Fi, Ethernet, and LTE. So, for example, when the Wi-Fi connection fails, the system will be able to provide a backup through another interface, say LTE, to make immediate troubleshooting possible.

Introducing IoT Cloud Connectivity to Residential Solar Systems

Connecting devices with each other doesn't necessarily lead to meaningful, usable, or useful interactions between devices. A number of connectivity platforms are now available to partially address the issue of integrating data from different disparate solar power systems. These systems enable interoperability, collaboration, and integration between solar energy systems within an IoT ecosystem. Moxa's IIoT computing platform is one such solution that can help integrate multiple devices and systems at a remote residential solar power site.

Moxa's Solutions

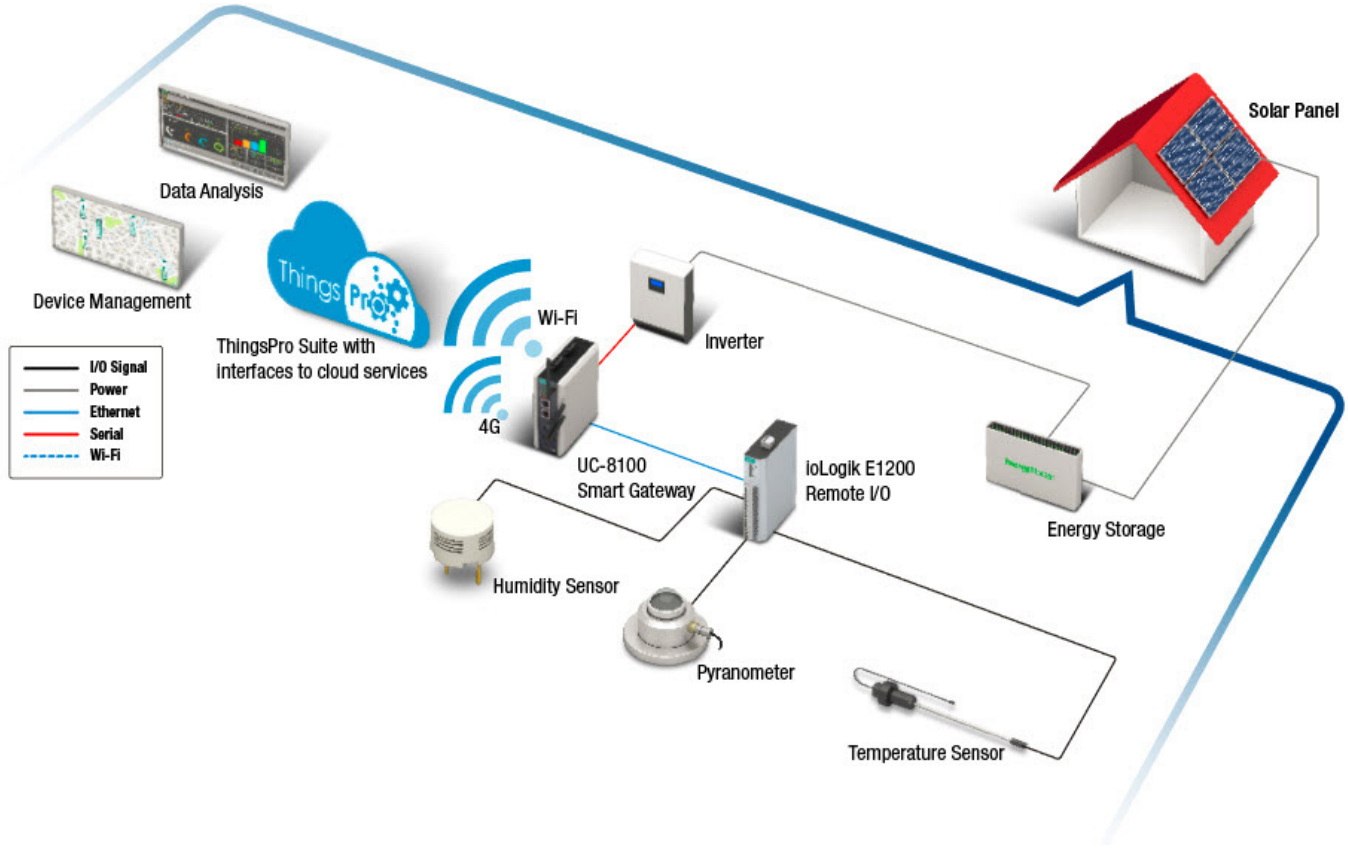

Figure 4: A Residential Solar System with Moxa's IIoT Computing Solution

Moxa's UC-8100 computing platform is designed for embedded data-acquisition applications in residential solar systems such as in Figure 4 above.

The UC-8100 computer comes with one or two RS-232/422/485 serial ports and dual 10/100 Mbps Ethernet LAN ports, as well as a mini PCIe socket to support cellular modules. Multiple communication interfaces, such as Wi-Fi, LTE, and Ethernet, provide versatility and let users efficiently adapt the UC-8100 to a variety of communication needs.

Moxa's UC-8100 Smart Gateway provides a Modbus library for seamless integration with ioLogik E1242 remote I/O units. This integration enables various functionalities to ensure optimal system status and the safety of the deployed systems, such as:

- Monitoring battery charging and discharging status
- Managing the system temperature
- Intrusion detection
- Controlling an alarm buzzer

Moxa's ThingsPro software suite is a game changer in the IIoT field. IT experts who have limited knowledge of industrial automation can use ThingsPro to efficiently and effectively manage data-oriented Industrial IoT applications. Our solution leverages the capabilities of the Industrial IoT gateway while still providing a powerful computing platform that eases IIoT deployments so that system integrators can deliver solutions and services faster and with minimum effort. ThingsPro saves users valuable setup time by automatically handling Modbus data acquisition and wireless management requirements, including LTE, while at the same time providing users with the flexibility to program their own applications so that they can extend the capabilities of their IIoT gateway.

Moxa's IIoT-gateway solution offers:

- Easy-to-use device management, enabling remote troubleshooting and firmware upgrades
- Easy-to-use GUI for data acquisition using Modbus protocol and with LTE-enabled routing capabilities
- MQTT support for a lightweight, asynchronous data exchange protocol in heterogeneous applications
- RESTful APIs for gateway configuration that take advantage of HTTP methodologies to provide application flexibility and insight into your IIoT device data

Moxa is determined to provide users with a solution that combines the capabilities of a pure computing platform with a data logger and an LTE gateway. Moxa intends to develop the ThingsPro Suite further by supporting it on more of our edge-computing platforms to offer users best-in-class programmable IoT gateways for industrial automation applications.