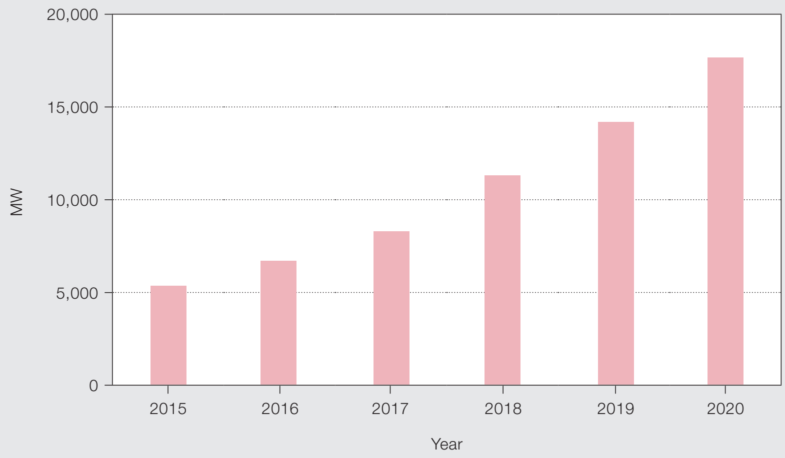
Self generation

Photovoltaics play an essential role in ABB's Active Site technology

LEONARDO BOTTI, PHILIP JUNEAU – What is the best way to connect rooftop photovoltaic panels, and how can users deploy them optimally? Photovoltaic technology has undergone a rapid transformation, both in terms of performance and cost, and is reaching the brink of competitiveness with conventional generation. Its installation is already viable without recourse to subsidies and incentives, and even with subsidy protection being decreased or abolished in many countries, the sector is continuing to see strong growth. However, the shift from conventional generation to solar generation is not just about replacing one source of power with another. It is also about a shift from centralized to distributed generation. With commercial, communal and industrial sites consuming and generating electricity as well as possibly having on-site storage, these sites are increasingly developing into microgrids. These microgrids need to be optimally managed and connected to the macrogrid. This is the role of ABB's Active Site technology.[1] This technology provides broad and comprehensive support for the emerging needs of the market. ABB provides an ideal solution for connecting and managing on-site photovoltaics (PV) using a broad range of state-of-the-art three-phase string inverters, including compact and outdoor devices and fast responding maximum power point tracking (MPPT).

1 Annual installed unsubsidized commercial and industrial PV



Source: IHS, BNEF

Subsidies for photovoltaics (PV) in the main European markets have become unviable and are being scaled down. Other mature markets will soon be seeing the same trend. But this is not bad news for solar energy generation. Significant cost reductions and rising retail tariffs have turned PV from a heavily subsidized and marginal technology into a mainstream and competitive source of power. Not only commercial users, but also residential households, are installing solar generation systems on their roofs to reduce their electrical bills. The self-consumption model, enabling residents to become "pro-sumers," means they can use energy generated on the premises, while also being able to either sell surplus or buy additional power as needed. Presently, such installations can be achieved without subsidies and can attain an IRR (internal rate of return) of more than 6 percent and a payback period of under 10 years (with an equipment life span double this). The figures are even more encouraging for commercial buildings and industrial complexes where the IRR can rise above 10 percent and the payback time fall below seven years – making them the best candidates to implement Active Site technology. Active Site can control and optimize the microgrid and its interface to the macrogrid, ensuring an optimization of energy usage and costs while permitting the microgrid to fully participate in the smart grid.

Title picture
Hospitals, campuses and factories, rather than being pure consumers of electricity, are increasingly also generating it. This picture of ABB's inverter factory in Helsinki, Finland shows the company is no exception. ABB's Active Site technology can help manage such sites and connect them to the grid.

Footnote
1 For more information regarding ABB's Active Site technology, please refer to "Active Site" on page 34 in ABB Review 4/2014.

In mature markets such as Europe and the United States the self-consumption model appears to work well, being financially viable and overall self-sustainable. Many analysis and research studies forecast that over 20 percent of electricity demand will be replaced by self-produced solar power by 2020 in these countries, thanks to over 60 GW of unsubsidized roof installations planned to occur within this timeframe ➔ 1.

In this scenario, with customer needs reaching a higher complexity level than ever before, competitiveness will be even more challenging for all energy providers, including the major utilities, whose role will shift from being energy providers to comprehensive energy service companies ➔ 2. Their ability to make this transition will be a key market success factor.

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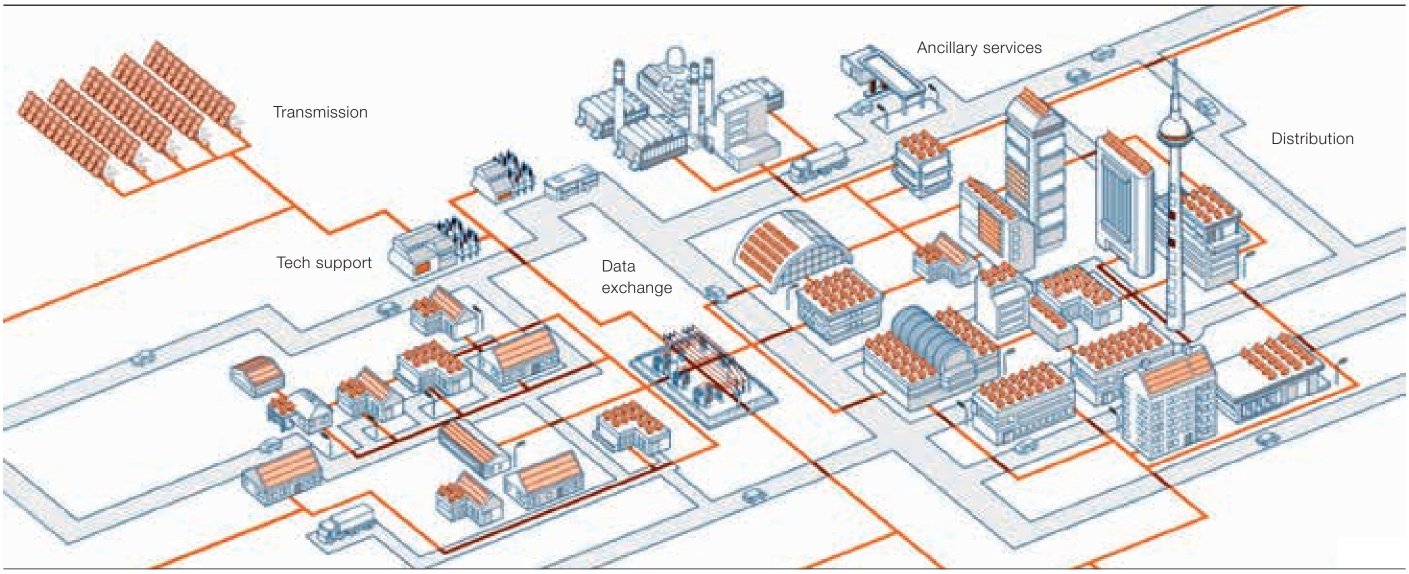
Enabling factors will be:
– Smart distribution capabilities (ability to master the technological complexity of the evolving grid)
– Expertise in energy management (experience in grid management as well as the necessary hardware and software tools)
– Technical prowess (expertise, professionalism and experience as well as recognition by customers and end users)

Distributed generation with PV

An electricity bill is an important expense at all consumption levels, from a single apartment to a large industrial complex. Being able to manage and control energy consumption is an important factor in cost control. On a commercial or industrial campus there are many different load profiles, characterized by individual buildings and objects. These profiles are

2 Energy services environment presenting the greatest potential for utilities



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heavily influenced by factors such as the weather, hourly usage profiles, etc. To manage this users must first implement a process to measure, analyze and determine the demand and consumption profiles on an equipment or asset level. This is possible by harnessing the plethora of energy meters, sensors and other measurement components within the building automation system.

Combining this data can not only provide a detailed and precise overview of present load profiles, but also help better forecast future ones. With this detailed data available, and combined with other pertinent information about the site, determining the best on-site generation capability is a relatively small next step.

To use a real-life example, a small industrial plant in Italy is evaluated ➔ 3. The plant, which manufactures plastic enclosures, was seeking to improve its energy performance by installing a PV installation on its roof. Following a detailed analysis of the electricity demand and consumption, with over 10.6 GWh annual power expenditure, a profile was determined ➔ 3b.

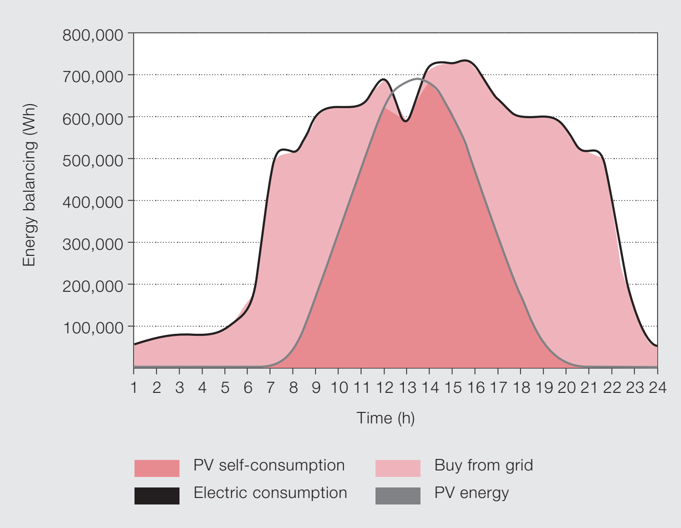
The shape of the curve is a good representation of the load activation time and perfectly matches solar availability ➔ 3a. Through simulations and analysis of all the different variables, ABB determined that the most effective solution was a 700 kW PV installation. This solution permits the site to consume 1.1 GWh/year and, assuming an electricity rate (taxes included) of 17 cents/kWh (0,156 EUR/kWh), results in a substantial savings of over $150,000/year (140.000 EUR/year) with a payback of slightly more than six years and an IRR of 11.5 percent. ABB's solution to achieving this goal is combining 24 units of TRIO-27.6-S2X and a single VSN-700-05 monitoring system, along with environmental sensors, low-voltage breakers and ancillary protections.

Local intelligence and virtual power plants

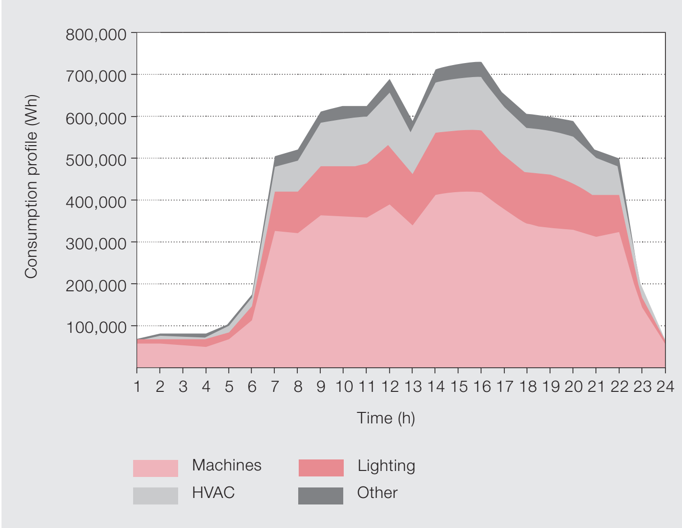
Power generation using small and flexible modules within the electrical grid is crucial to achieving a truly decentralized electrical system. An Active Site featuring distributed solar generation is the most effective way to attain this goal. Under certain conditions, such installations can become virtual power plants (VPPs), featuring a continuous exchange of data between microsites and the grid. VPPs enable the provision of system services in the transmission and distribution network (eg, control power in the so called "minute reserve capacity") configured by combining loads from end-use equipment with emergency generating units and distributed generation. The VPP aggregates the electrical output from a multitude of objects and makes this supply available to the distribution system. When requested, the VPP controls the immediate dispatch of electrical output to the connected plants, contributing to grid stability.

ABB's three-phase string inverters fitted in industrial campuses as well as in commercial buildings play a crucial role in

3 Real world example: factory in Italy



3a Daily energy balancing at site with local PV



3b Daily consumption profile for the site

bringing these Active Sites to the VPP level. Thanks to their multiple maximum power point tracking (MPPT), these inverters can maximize site production.

Looking at grid requirements in detail, the ABB inverter product lines PVI, TRIO and PRO provide a wide range of reactive power and fault ride through functions. Coupled with frequency/voltage management control, they make an important contribution to network stability. The benefits of VPPs for energy providers include:

- The option of "trimming" electrical demand peaks, thus securing a higher stability level for the energy production facilities. This indirectly provides consistent savings in terms of the additional costs otherwise required to meet higher peaks for short periods.
- Reduces the need for backup systems due to the lower consumption and the better energy flow management achieved. This allows closing legacy generation plants (capex reduction).
- Avoids replacement of old and/or obsolete power plants with new power generation facilities (capex avoidance). This is a critical item in many countries where massive investments are the main alternative.
- Reduces expenses on legacy grids by leveraging the Internet of Things with the use of applications (apps) via smart tablets and smartphones. Such end-user apps will help reduce general and administrative efforts.
- Extraordinary ability to perform real-time diagnostics when faults occur with the opportunity to perform effective preemptive interventions, thus saving on maintenance expenses (opex).

> Algorithms and operating schemes provided by the grid operators balance the energy operation of the site with the aim of minimizing wastage and meeting network fluctuations.

Communications

Optimizing a site's self-consumption is the way to make the most of solar-based electricity, but to do so requires a continuous and reliable exchange of data between the different participants in the decentralized electrical system, namely generators, loads and the grid. ABB's Active Site architecture bases its communication on multiple protocols to ensure that all possible inputs are analyzed and managed by the Active Site control system. The system's communication connects loads, switches, sensors and meters and distributed solar generators. Algorithms and operating schemes provided by the grid operators balance the energy operation of the site with the aim of minimizing wastage and meeting network fluctuations. ABB solar inverters can communicate using a range of protocols including ModBus, TCP/IP and RS 485 as well as open gateways. They are fully integrated into the building automation system and can exchange data continuously with the overall Active Site energy management system.

PV installations are a vital part of ABB's Active Site concept. Coupled with a company's energy storage and building automation technologies, the PV installations have a vital part to play in energy independence and sustainability.

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