Dave Bolick – sample article – Inverter Technology
510-601-9554 – db@davebolick.com

Photovoltaics World

Inverter Technology Driving Lower Solar Costs

Introduction

Solar power is poised to go mainstream in North America. In the U.S.—the world's leading energy consumer—the solar market is especially ripe. As with any new technology, though, how fast it happens depends largely on economics.

A supply glut of solar-grade silicon, for example, is driving down solar module prices, and on the legislative side, the Obama administration's renewable energy stimulus package includes tax incentives for new solar PV systems. Feed-in tariffs such as the one in place in Ontario, Canada are also boosting solar adoption rates.

With solar module prices falling due to their increasing commoditization, more attention is being paid to other components of the solar installation.

Installation Costs

Solar system installation costs include three main components: solar module, 50 percent; Balance-of-System (BOS) and labor, 40 percent; inverter, 10 percent and rising.

<insert pie-chart graphic>

Source: http://www.solarbuzz.com/ModulePrices.htm

Solar module prices, while still accounting for the majority of overall system costs, have come down significantly—as much as 50 percent compared to 2008. Modules are becoming increasingly commoditized, and as prices drop, the costs of BOS, labor, and inverters become more important.
prices. (Source: http://www.deloitte.com/view/en_US/us/Insights/Browse-by-Content-Type/deloitte-review/article/cd308136aaea2210VgnVCM200000bb42f00aRCRD.htm)

Therefore, the BOS and inverter segments have seen increased interest over the past few years, and there's been a surge of investment and development in these areas, particularly in the inverter market.

One reason why inverters have received so much attention is changes in inverter technology, which impact not only inverter costs, but also BOS and labor costs. Improved inverter technology can also help with other challenges that PV must overcome to gain widespread acceptance in the marketplace.

New Inverter Technologies

Inverter R&D has focused on two areas. The first is incremental changes in the existing string/central inverter, most of which are geared toward larger installations. These changes have led to bigger, more centralized inverters, for example, SMA's new 500-kilowatt 500U PV inverter.

The second recent inverter development is a move toward decentralized architectures, including partial solutions such as DC-to-DC optimizers, consisting of add-on electronics designed to augment a central inverter, and full inverter solutions such as microinverters.

Decentralized inverter solutions are designed to solve some of the significant challenges experienced in the PV industry. Inverter technology directly impacts four major challenges for PV market growth in the U.S.: system cost, energy harvest, reliability, and safety.

System Cost

Inverter prices have not come down significantly in the past few years, and with module prices falling, inverters represent a greater portion of the total cost of a solar installation. As mentioned, inverter technology can also have a significant impact on BOS and labor costs.

New AC-based inverter systems can incorporate AC-BOS equipment rather than DC junction boxes, connectors, and fuses. Generic AC equipment is much cheaper than specialized DC-BOS, and so total installation expenditures can be reduced significantly. Similarly, new inverter technologies, e.g., microinverters, avoid the need for a large central inverter, further reducing installation costs. This is particularly true for larger systems, where the large inverter can require installing a concrete pad, an air-conditioned hut, fencing, and a crane to lift the inverter into place.

New inverter technologies also have the potential to reduce solar array operating costs. Newer technologies make the array less prone to performance degradation from dust and debris, meaning less frequent washing. Also, inverters based on a distributed architecture allow for delayed maintenance. In this type of highly redundant system, if one inverter fails, the failure is limited to a small section of the array. The rest of the array will continue to operate normally. Maintenance costs are lower because microinverters can be swapped out quickly and easily, and by less-skilled staff—compared to large central inverters, which require expert diagnosis, repair, removal, and replacement.

Energy Harvest

Inverter technology has always had a significant impact on energy harvest. The serial nature of module installation results in the "Christmas light effect," i.e., any impact (dust, debris, shade) on module performance will also affect the other modules in the

string. Distributed inverter architectures mitigate this effect as each module becomes an independent power generator. Per-module MPPT enables increased energy harvest. SunEdison recently installed their first microinverter-based system, resulting in energy harvest numbers 20 percent greater than the figures estimated during the design process.

Reliability

Every installer knows about inverter reliability problems. The biggest headache is sending a tech to a site repeatedly to troubleshoot an inverter failure, return to install a replacement unit, and so on. New, distributed inverter technologies include per-module monitoring, allowing the installer to identify malfunctioning modules quickly and easily, and then simply swap-out the problem inverter.

Safety

Increasing PV safety means minimizing the risk of fire and arcing. PV fire safety has two aspects: prevention and suppression. AC-based inverter technologies can help reduce fire risk because an arc in an AC system self-extinguishes 120 times per second (on a 60Hz power system), whereas a DC arc is continuous. AC-based systems are also safer for firefighters. An AC-voltage distribution system can be shut off prior to fighting the fire, while the widely distributed high-DC voltage of a DC system remains energized whenever the sun is shining.

Future Trends

The next logical step for inverter technology is integration into the PV module, to create an AC module. This evolution will benefit all members of the solar value chain significantly. Module manufacturers like the concept as a way to “decommoditize” their offerings, thereby enhancing revenues and profits. It removes an entire step in the installation process and streamlines ordering and procurement, and of course system owners get the benefits of an integrated solution.

Distributed architecture is a significant leap forward for inverter technology. With the market share inroads that microinverters have made, we can expect to see additional models introduced. And as these advances continue to drive lower installation and maintenance costs, the industry will eventually reach a price point where mass adoption becomes inevitable.