Standalone PV Systems: Past, Present & Future

Solar panel installation at an information center adjacent to Ögii Lake (Chinneeb, Creative Commons Attribution-Share Alike 3.0 Unported, https://en.wikipedia.org/wiki/File:Solar_panels_in_Ogiinuur.jpg)

Stand Alone Photovoltaic (PV) systems are amongst the oldest of applications of photovoltaic systems, and are a testament to photovoltaic technology's ability to operate in the most extreme of conditions. They are typically used in isolated locations with low or no population, or in place of conventional grid infrastructure in less-developed regions.

Standalone systems, as the name suggests, are energy systems designed to operate independent from a grid source of electricity. These systems may be powered by a variety of energy sources, such as wind, hydro, solar, geothermal, or fossil fuels and typically contain some form of energy storage technology. These systems are designed to operate at any location, using the energy sources available. This is important especially at remote locations without a grid connection, or at places where the grid itself is inherently unreliable.

Standalone PV systems started small but with a highly specialized purpose and at a very high cost… in space. PV technology surged along with the space race in the 50s and 60s, and became providers of electrical energy to orbiting satellites and space stations, sometimes in conjunction with a modular nuclear reactor. It was highly successful, and even shaped the future of space technology; even to this day, satellites, probes, and space stations rely on solar panels. Meanwhile, back on Earth, standalone systems that featured solar panels were only beginning.

In 1966, Japan installed the largest solar array at the time on a lighthouse. It was rated at 225 watts. The cost was still too prohibitive for most applications.

The two oil crises in the 1970s led to greater interest in energy independence, especially in the form of renewable energy. Scientific and engineering institutes started to push towards making solar cells more efficient. Manufacturing techniques improved and cell efficiencies increased to a point where the cost per watt significantly dropped, making them more affordable and opening new markets.

PV panels were coupled with battery systems for the purpose of telecommunications, navigation aids, relay stations, and for other low power but critical needs. There was also a groundswell of public interest in solar energy use as a result of the energy shortage, and standalone PV systems started appearing in domestic applications. Even petroleum companies started to purchase solar panels to power warning lights and corrosion prevention equipment at oil rigs.

In Australia, the 1970's saw experimental use of standalone PV for rural telephones and repeater stations. With the drop of the price of solar panels, the telecommunications industry was able to deploy stations across the country with great success.

A significant proof-of-concept of standalone PV systems is the powering of a village in a Native American Reservation in Arizona in 1978. The

system powered 15 homes and water pumps for the village for 10 years, until the reservation became connected to the grid.

By the end of the decade the use of standalone PV was being implemented in development projects in developing countries around the globe. In countries with vast agricultural regions, standalone PV was, and still is, one of the best ways to power irrigation systems and farming equipment when the grid connection was not available. Clinics, hospitals, and hotels started to see standalone PV as a reliable and cheaper energy source compared to their existing but expensive diesel powered systems.

The 1980's saw PV installed in of millions of consumer electronic devices, and saw a surge of standalone and grid connected PV applications as the price of panels dropped further. Central America, Mexico, Caribbean Nations, and several African countries saw communities connect to standalone PV systems, powering up their homes, their TV sets, and fridges. Standalone PV systems started to be integrated into homes and buildings – becoming part of the building-integrated photovoltaics movement in architecture. Further advances in solar technology also saw solar thermal playing a significant role in supplementing standalone applications, especially systems located in arid regions with plenty of solar resource.

In 1990's and 2000's governments around the world started to put forward grants, concessions, tax cuts, and other financial instruments for the purpose of expanding the solar industry to a wider customer base. Germany became the a leader in the solar movement, as significant incentives and forward-thinking government policies allowed solar and wind to become major providers of energy to the country. Meanwhile in Australia, the renewable energy certificates assisted small standalone PV systems, and agricultural regions saw benefits in the form of rebates for solar water pumping. This further made it financially attractive for remote stations and farms to move to standalone PV systems, with great success.

It became clear towards the late 2000's that standalone PV could be used in a myriad of situations where power was required on-the-spot and for immediate consumption, such as in car parks, energy intensive industry, emergency response equipment, and portable RV systems. The solar boom of the early 2010's saw panel prices plummet to lows never seen before and installations numbers to rise significantly.

By this stage, PV was already being considered an essential piece of equipment for standalone systems, not only in the developed world but in developing countries, since the low cost of the equipment plus the non-existent fuel requirements meant that these systems could be put virtually anywhere on the planet.

An application proposed for standalone PV systems is remote electrical vehicle charging stations. With electric vehicles becoming increasingly common, the idea of having solar powered charging stations is gathering a lot of attention. Imagine being able to drive from Sydney to Melbourne in an electric car and have a break every now and then to charge your car batteries from electricity provided by solar panels even in the middle of nowhere. This could be done anywhere in the world too, particularly in the United States where electric vehicles are subsidized in the west coast.

The Solar Settlement with the Sun Ship in the background: *Freiburg, Germany (Andrewglasser, Creative Commons Attribution-Share Alike 3.0 Unported, https://en.wikipedia.org/wiki/File:SoSie%2BSoSchiff_Ansicht.jpg)*

What is the next step for standalone PV systems?

With the advent of batteries with increased capacity and the portability, as seen by the various lithium based battery technologies, standalone systems are being heavily considered for in the application of mini-grids. These systems, essentially large scale standalone systems that operate like a grid, can serve the purpose of providing energy from multiple sources for a community separate from the grid. This is likely to be widely implemented as increasing awareness of the effects of fossil fuels on the environment and increasing costs of electricity puts standalone PV forward as a cheaper alternative.

The concept of mini grids is of great significance, since it means that entire communities can be powered autonomously. What is more noteworthy however is the possibility of having entire neighbourhoods or suburbs that are currently connected to the traditional grid becoming separate and running independently through PV, wind, geothermal, or hydro where possible, with a grid connection as a backup supply, increasing the reliability of the system.

A recent example of the transition to mini grids in grid-connected communities is the AusNet trial to disconnect 14 homes in a Melbourne city suburb and have energy provision solely by means of solar and battery storage facilities, with the intention of demonstrating a functional self-sustaining mini grid which has the added benefit of deferring network upgrade.

In Europe, this has been done at much larger scales. Many villages in central Europe have become fully independent from the electricity grid by means of 'community solar', a financial instrument in which the community itself invests in having solar, wind, and batter storage in order to provide for their energy needs, independently from the grid. This has proven to be very successful in regions in Germany, which has seen many of its electricity retailers struggle to compete against the unsurmountable rise of solar and wind energy.

The renewable energy industry will see great advances in the next few years with the implementation of battery storage in homes and businesses, and systems capable of off-grid operation will be part of this future. As members of the renewable industry, we need to be aware of the transition from grid-connected PV systems to hybrid systems as big changes in the electricity industry occur.

GSES currently provides training courses on Grid-connected PV Systems with Battery Storage and publishes the PV Systems with Battery Storage Training Handbook. GSES also publishes the Stand-Alone Power Systems Training Handbook, and look to offer training on standalone power systems in Q4 2016.

GSES will also be at the Australian Energy Storage Conference and Exhibition, June 1st- 2nd at Australian Technology Park, Sydney. We will be running workshops throughout the day and holding a booth at booth number 401. Drop by and say hi!

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