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In 1954, the world had less than a watt of solar cells capable of running electrical equipment. Fast-forward through 50 years of continued discovery and development of silicon and other PV materials and this is what you’ll see. Today, a billion watts of electricity generated by solar cells help to power the satellites so necessary for modern life, ensure the safe passage of ships and trains, bring abundant water, lighting, and telephone service to many who had done without, and supply clean power to those already connected to the grid. The worldwide market for solar electric energy has grown by 20%-25% per year over the past 10 years. According to Solarbuzz, the international solar electric industry now generates around $3-$4 billion (U.S.) in revenues each year. The inventors of the Bell Solar Battery, from left, Gerald Pearson, Daryl Chapin, and Calvin Fuller, check devices for the amount of solar electricity derived from sunlight, here simulated by a lamp.

Daryl Chapin began work in February 1952, but his initial research with selenium was unsuccessful. Selenium solar cells, the only type on the market, produced too little power—a mere 5 watts per square meter—converting less than 0.5% of the incoming sunlight into electricity. Word of Chapin’s problems came to the attention of another Bell researcher, Gerald Pearson. The two scientists had been friends for years. They had attended the same university, and Pearson had even spent time on the Chapins’ tulip farm.

At the time, March 1953, Pearson was engaged in pioneering semiconductor research with Calvin Fuller. They took silicon solid-state devices from their experimental stage to commercialization. Fuller, a chemist, had discovered how to control the introduction of the impurities necessary to transform silicon from a poor to a superior conductor of electricity. Fuller provided Pearson with a piece of silicon containing a small concentration of gallium. The introduction of gallium made it positively charged. Pearson then dipped the gallium-rich silicon into a hot lithium bath, according to Fuller’s instructions. The spot where the lithium penetrated created an area of poorly bound electrons and became negatively charged.

Then came the test. Pearson shined light from a lamp onto the lithium-gallium silicon. One can only guess whether or not he crossed his fingers. An ammeter connected to the silicon recorded a significant electrical flow. Much to his surprise, Pearson had made a solar cell superior to any other available at the time.
Switching to Silicon

Pearson went directly to Chapin’s office and advised him to switch to silicon, rather than wasting another moment on selenium. Chapin’s tests on this new material proved Pearson right. Exposing Pearson’s silicon solar cell to strong sunlight, Chapin found that it performed significantly better—five times more efficiently, in fact—than selenium. Theoretical calculations brought even more encouraging news. An ideal silicon solar cell, Chapin figured, could convert 23% of sunlight into electricity. Developing a silicon solar cell with 6% conversion efficiency, though, would satisfy Chapin and rank as a viable power source. His colleagues concurred, and all his work focused on this goal.

However, try as he might, Chapin could not improve on Pearson’s accomplishment. "The biggest problem appears to be making electrical contact to the silicon," Chapin reported. Not being able to solder the leads directly to the cell forced Chapin to electroplate a portion of the negative and positive silicon layers in order to tap into the electricity generated by the cell. Unfortunately, no metal plate would adhere very well, thus presenting a seemingly insurmountable obstacle to collecting more of the electricity generated. Chapin also had to cope with the inherent instability of the lithium-bathed silicon, because the lithium migrated through the cell at room temperature. This caused the location of the p-n junction, the core of any photovoltaic device, to shift from its original location near the surface, making it more difficult for light to penetrate the junction where all electrical activity occurs.

Then an inspired guess changed Chapin’s tack. He correctly hypothesized that “it appears necessary to make our p-n junction very near to the surface so that nearly all the photons are effective.” He turned to Calvin Fuller for advice on creating a solar cell that would permanently fix the p-n junction very close to the top of the cell. Coincidentally, Fuller had done that very thing two years earlier while trying to make a transistor. He therefore replicated his prior work to satisfy his colleague’s need. Instead of doping the cell with lithium, Fuller vaporized a small amount of phosphorus onto the otherwise positive silicon. The new concoction almost doubled previous performance records. Still, the lingering failure to obtain good contacts frustrated Chapin from reaching the 6% efficiency goal.

The Competition Heats Up

While Chapin’s work reached an impasse, Bell’s competitor, RCA, announced that its scientists had come up with a multianode powered silicon cell dubbed the Atomic Battery. Its development coincided with America’s Atom’s for Peace program, which promoted the use of nuclear power throughout the world. Instead of photons supplied by the sun, the Atomic Battery ran on photons from strontium-90 (which is now classified as one of the more hazardous constituents of nuclear waste). To showcase the new invention, RCA decided to put on a dramatic presentation in New York City. David Sarnoff, founder and president of RCA, who had initially gained fame as the telegraph operator who tapped out the announcement to the world that the Titanic had sunk, hit the keys of an old-fashioned telegraph powered by the Atomic Battery to send the message: "Atoms for Peace."

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The Atomic Battery, according to RCA, would some day power homes, cars, and locomotives with radioactive waste—strontium-90—produced by nuclear reactors. What its public relations people failed to mention, however, was why the room’s blinds had to be closed during Sarnoff’s demonstration. Years later, one of the lead scientists involved in the project told the rest of the story: If the silicon device had been exposed to the sun’s rays, solar energy would have overpowered the contribution of the strontium-90. Had the nuclear component been removed, the battery would have continued to work on sunlight if allowed to stream into the building. "Who cares about solar energy?" said the director of RCA Laboratories. “Look, what we have is this radioactive waste converter. That’s the big thing that’s going to catch the attention of the public, the press, the scientific community.”

The director had gauged the media well. The New York Times, for example, called Sarnoff’s demonstration "prophetic," and predicted that power from the Atomic Battery would allow "hearing aids and wrist watches [to] run continuously for the whole of a man’s useful life."

Proof of Concept

RCA’s success stirred management at Bell Laboratories to pressure the solar investigators to hurry up and produce some-
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With each passing year, the expectation triggered by the pioneering work of Chapin, Fuller, and Pearson—the harnessing of almost limitless energy from the sun—comes closer to being fulfilled. But the revolution is not yet won. The hope for the next 50 years is to see solar cells providing power throughout the world and being used in ways we can’t even imagine today.

Advertisement photos, such as this one that appeared in the 1956 issue of Look Magazine, show off the “Bell Solar Battery” to the American public.