INVENTIONS & INNOVATION

Project Fact Sheet

Simple Design and Manufacturing Process for High-Intensity Silicon Vertical Multi-Junction Solar Cells

Benefits

- Provides higher voltage and lower current operation than typical solar cells
- Offers lower costs through high efficiency at high intensity
- Does not require photolithography processes
- Requires less silicon than conventional solar cells
- Simple design results in lower manufacturing costs
- One-wafer design can be used for all intensities and to make a wide range of cell sizes
- Low series resistance at high intensities

Applications

The VMJ cells should have immediate application for bulk electric power generation for larger-scale (>100kW) central power stations in sunny, semi-arid regions of the world. The growing demand for "green" utility power in developed countries may accelerate the application of concentrator photovoltaic cells and systems. The cells may also find use in small dish power systems and may replace diesel generators by supplying lighting and portable power generation in rural areas.

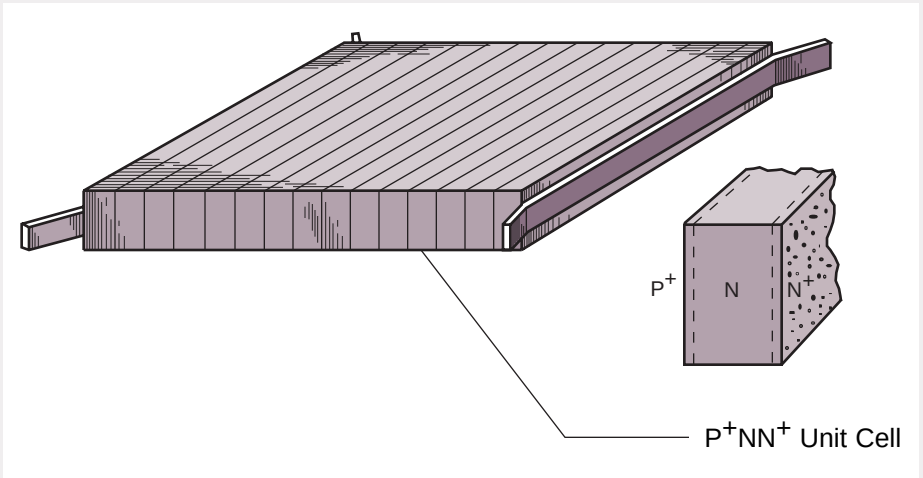
Breakthroughs in Solar Cells in Photovoltaic Concentrator Systems Create Cost Savings

Since the oil crisis in the early 1970s, industry, federally funded laboratories, state and local governments, and the academic community have sought to advance renewable energy resources for a more secure energy future. Renewable energy resources, such as wind, biomass, and solar power, are currently being developed to help reduce U.S. dependence on foreign oil and lessen the environmental impact of emissions created by fossil fuel energy.

Within the growing solar industry, research has focused on the creation of solar concentrators that make photovoltaics more cost-effective. From 1975 through 1992, an estimated $40 million was invested in concentrator development worldwide. Despite this capital investment, the concentrator community has encountered difficulties in demonstrating complete system reliability. This failure, coupled with the expenses that result from limited production, has hindered market demand for these concentrators.

However, a new development in concentrator technology may change the future of concentrators. PhotoVolt, Inc. is developing a high-efficiency, low-cost solar concentrator cell. This innovation offers technical and economic benefits along with a much simpler cell design and manufacturing process. PhotoVolt's patented Vertical Multi-Junction (VMJ) cell requires far less silicon than conventional cells, which should help to minimize price fluctuations due to silicon availability.

Vertical Multi-Junction (VMJ) Solar Cell



This high-intensity silicon VMJ solar cell combines higher voltage and lower current operation to create highly efficient, concentrated solar power conversion.

Project Description

Goal: Finalize fabrication processes for a low-cost, high-intensity silicon vertical multi-junction (VMJ) solar cell. In addition, the project will demonstrate the VMJ cell's performance viability in solar concentrators under a cost-sharing relationship with a third party.

While solar concentrators have not yet gained widespread market acceptance, market forecasts for worldwide photovoltaic applications remain positive. By 2010, the amount of power generated by central power stations (solar concentrators) is expected to reach 600 megawatts, up from only about 10 megawatts in 2000. This growth is primarily expected in areas with semi-arid, sunny regions. In these areas, concentrator photovoltaic (CPV) systems are more efficient than other alternative technologies.

The VMJ cell's efficiency, low internal loss, high-output voltage rating, low manufacturing costs, and robust reliability are expected to compare very favorably to existing concentrating cells. With these factors considered, the VMJ cell could become the next industry leader.

PhotoVolt, Inc. is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- PhotoVolt, Inc. is finalizing the fabrication processes for a pre-production prototype and producing VMJ cell samples for demonstration and evaluation.
- Technical feasibility was proven under the Department of Energy (DOE) Inventions and Innovation Program with approximately 20 percent efficiency at 33.2 watts/cm^2.
- PhotoVolt, Inc. holds three U.S. patents on the VMJ cell's design and manufacturing process and has attracted the interest of a concentrator system developer. Together, these companies hope to market and install several prototype CPV systems in a privately held electric transmission company overseas.

Economics and Commercial Potential

Installation costs for one of the leading manufactured silicon-based dish concentrator cells are between $1.99/Watt (W) and $4.02/W. In comparison, the VMJ silicon cell is projected to have an installation cost of between $1.00/W and $2.00/W. Flat-plate PV cell technology has never cost less than $2.50/W per module. Under this comparison, the VMJ cell's projected costs are the most competitive.

Industry watchers agree that solar concentrators are a renewable energy option worth pursuing for certain applications, such as central power stations and small dish systems in semi-arid areas. There is further agreement that the remaining technical issues causing reliability problems can be resolved.

The most successful approach to developing a sustainable commercial market is to provide a reliable, cost-competitive CPV system to the customer. One of the keys to developing this commercial market will be providing a highly efficient and readily producible solar cell like the VMJ. If the CPV system meets customer requirements for reliable and affordable alternative power, then it should be well received by industry.

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

Project Partners

Inventions and Innovation Program
Washington, DC

PhotoVolt, Inc.
Strongsville, OH

For project information, contact:

Mr. Bernard L. Sater, P.E.
PhotoVolt, Inc.
21282 Woodview Circle
Strongsville, OH 44149
Phone: (440) 878-1073
Fax: (440) 546-9786
VMJcells@aol.com

For program information, contact:

Lisa Barnett
Program Manager
Inventions & Innovation Program
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585-0121
Phone: (202) 586-2212
Fax: (202) 586-7114
lisa.barnett@ee.doe.gov

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Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, DC 20585-0121

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