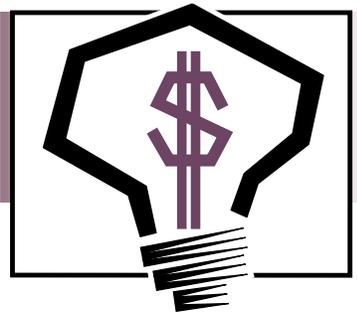


INVENTIONS & INNOVATION

Project Fact Sheet



SIMPLE DESIGN AND MANUFACTURING PROCESS FOR HIGH-INTENSITY SILICON VERTICAL MULTI-JUNCTION SOLAR CELLS

BENEFITS

- Generates up to 1000 times the output power density of typical one-sun solar cells
- Provides higher voltage and lower current operation than other solar concentrator cells
- Offers lower \$/watt costs through high efficiency at high intensity
- Requires no photolithography processes
- Simple design results in lower manufacturing costs
- Makes expensive silicon material an insignificant cost factor

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.

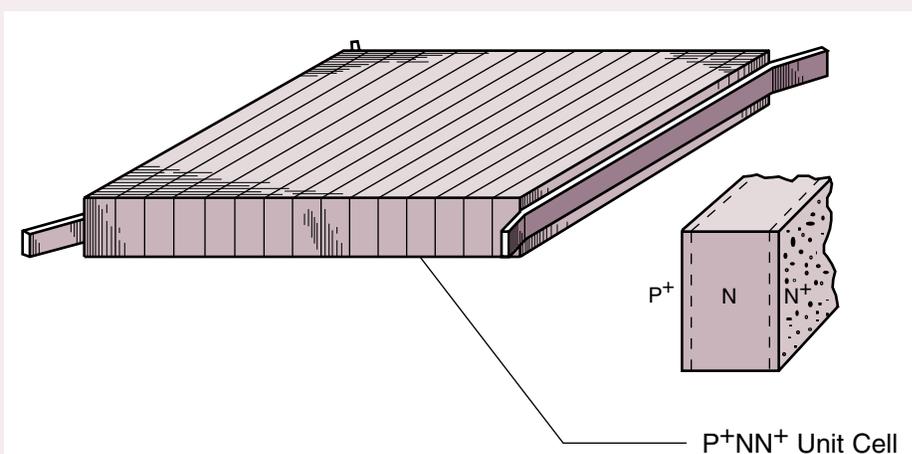
BREAKTHROUGHS IN SOLAR CELLS IN PHOTOVOLTAIC CONCENTRATOR SYSTEMS CREATE COST SAVINGS

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 provides up to 1000 times the output power density of typical one-sun solar cells, which effectively makes expensive silicon an insignificant cost factor.

VERTICAL MULTI-JUNCTION (VMJ) SOLAR CELL



This high-intensity silicon VMJ solar cell, being developed by PhotoVolt, Inc., 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 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/cm².
- 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 to 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.

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Order# I-OT-777
October 2001