ABOUT THE IMAGES

High-performance solar power plant in Alamosa, Colorado. It generates electricity with multi-layer solar cells, developed by the National Renewable Energy Laboratory, that absorb and utilize more of the sun's energy.
(DENNIS SCHROEDER / NATIONAL RENEWABLE ENERGY LABORATORY)

LED lights are not only very efficient, but can be "tuned" to emit light of different colors for different purposes—"warm" white light for human residential use, harsher white light for outdoor security, still another "cooler" white light to help plants grow optimally for indoor agriculture.
(SHUTTERSTOCK.COM)

TURNING SEMICONDUCTORS ***INTO CLEAN ENERGY TECHNOLOGIES***

Semiconductor technology is what has powered the IT revolution, providing ever smaller, less expensive chips. Less well known are newer semiconductor technologies that are transforming the lighting industry and creating super-efficient solar cells to power smart watches, smart buildings, and smart highways. This second semiconductor revolution is based on several decades of fundamental research supported by the DOE Basic Energy Sciences office into the properties of semiconductor materials and applied research by the DOE Energy Efficiency and Renewable Energy office into novel processes for manufacturing practical devices.

The Breakthrough

Understanding how semiconductors emit and capture light.

- LED lighting. Patient research in many laboratories led to a detailed understanding of how semiconductor devices known as light-emitting diodes (LEDs) actually work, as well the ability to control the complex process by which they are manufactured. It also led to the incorporation of a new nanotechnology called quantum dots into advanced LED devices to more efficiently and precisely emit the white light needed for conventional lighting.
- Multi-layer solar cells. Basic and applied researchers at the National Renewable Energy Laboratory worked together to understand and eventually control the properties of complex semiconductor materials that capture light and then to create solar cells with multiple layers of different materials—each absorbing a different portion of sunlight—enabling these devices to capture far more of the sun's energy.

The Impact

Transforming the Lighting Industry and Powering the Internet of Things

- LED lights last far longer and will be 15 times more energy efficient than incandescent bulbs. This new semiconductor technology is rapidly transforming the light industry and is expected to save energy and help U.S. businesses and consumers lower their lighting bill.
- Multilayer solar cells that are candidates for commercialization now contain four layers and are approaching 50 percent efficiency. Major U.S. IT companies such as Apple and Google as well as several start-ups are now building on the DOE research to commercialize these devices. They will become the power source for smart watches and the tens of millions of internet-connected sensors and micro-controllers needed for smart homes, smart buildings and smart transportation networks.

The Takeaway

Patient fundamental research into the properties of complex semiconductor materials is furthering the clean energy agenda and catalyzing major new industrial sectors.

Adapted from chapter 1 of A Remarkable Return on Investment in Fundamental Research, U.S. DOE, June 2018.
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