Argonne launches unique research initiative to realize solar energy's full potential

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Argonne researchers are experimenting to improve solar cells to harness more of the sun's energy. Photo credit: Nicholas Hoizey

(PhysOrg.com) -- Spurred by global development and population growth, the world's energy needs are expected to double by 2050. The best solution to meet this coming demand is an energy mix that includes generous amounts of renewable energy sources such as solar, wind and biofuels, as well as nuclear energy and fossil fuels.

Of the many options, the sun represents the most abundant renewable energy source. Its rays have a potential supply that dwarfs the global demand for energy today and for the foreseeable future. However, the costs of converting sunlight to usable electricity, heat or fuel must be radically reduced to realize this potential. And that can only be accomplished through the development of technologies that are low-cost, highly scalable and based on plentiful source materials.

Dozens of researchers at the U.S. Department of Energy's (DOE) Argonne National Laboratory are exploring new solar technologies as part of its Alternative Energy & Efficiency Initiative. The initiative aims to achieve revolutionary advances toward the large-scale use of solar energy by merging basic and applied research that is supported by collaborations with industry and other research organizations.

Argonne's solar energy research covers four specific areas: next-generation photovoltaic technologies such as organic, hybrid and dye-sensitized solar cells; transparent conductors deposited on 3-D photovoltaics; concentrating sunlight; and systems analysis.

Current photovoltaic technologies perform well, but their costs are too high to compete directly with fossil fuels. Without significant government subsidies, incremental improvements to these technologies will not lower costs enough to achieve grid parity, where the costs are equal to or lower than burning coal, for example.

Next-generation technologies with potential for very low-cost production are needed. Organic, hybrid and dye-sensitized solar cells are among the most promising of these low-cost options. Basic science is needed to design, synthesize and understand these materials, and applied science to optimize performance and scale up the fabrication of devices based on these materials. Furthermore, systems analysis will provide insight into how the complex interplay of issues such as variability of sunshine, geographic and resource factors, regulation and economics will impact the market penetration of these technologies.

Light must enter into one side of a solar cell, and that side also has to serve as an electrode for the device to function—so transparent conductors are a crucial component of virtually all solar cells. Indium tin oxide is the workhorse of transparent conductors in today's devices. But the world's indium supply is limited, so alternatives are needed to reduce

the amount required or eliminate it altogether. Argonne has a team of experts in a technique called atomic layer deposition (ALD) that can prepare extremely thin layers of transparent conductors.

ALD also provides perfectly conformal coverage, even on highly three-dimensional materials such as those required for dye-sensitized solar cells. Using ALD to deposit indium tin oxide will enhance performance and reduce the cost of next-generation photovoltaics. Extending this technique to alternative, earth-abundant transparent conductors will ultimately bring us closer to fabricating efficient solar energy devices on a massive scale.

Sunlight is bountiful but diffuse. Another route to lowering the cost of capturing solar energy is to use inexpensive materials to collect sunlight from a large area. This light is directed either to a small, high-performance solar cell or to a fluid that transfers the thermal energy to steam turbines that generate electricity. Argonne has a program developing luminescent solar concentrators for the first approach that will function in a broad variety of climates and another program studying advanced heat transfer fluids for the second, which performs best in regions with abundant sunshine. Because numerous factors could influence the commercial viability of these technologies, systems analysis will provide essential direction regarding device targets and appropriate markets.

Argonne is also exploring in detail the environmental impact of shifting to new solar energy technologies on a large-scale and examining how consumers will respond to these technologies.

Photovoltaics and concentrated solar power hold the promise of ushering in a new energy economy for the electricity grid. Looking forward even further, turning sunlight into chemical fuels is an exciting route to replacing fossil fuels in the transportation sector; the laboratory is laying

the groundwork to tackle this goal, too.

Argonne's integrated approach to solar energy research represents a new way of addressing the challenges associated with shifting global energy generation away from fossil fuels to provide a clean, secure and virtually limitless supply of energy in the future.

Provided by Argonne National Laboratory

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