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Report on Campus Innovation: ALTERNATIVE ENERGY

Waterloo scientists pursue the elusive dream: efficient solar power

Mission of new research centre: Make electricity generated by sunlight more affordable

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Like a vision in the desert, economically feasible solar power has always seemed just out of reach. Given technological advances we should be able to harness the sun's huge energy output to replace increasingly scarce and polluting fossil fuels. But even with recent leaps in oil prices, solar can't compete in most of the world.

In Canada, electricity costs five to seven cents a kilowatt hour, says Siva Sivoththaman, a professor of electrical and computer engineering at Ontario's University of Waterloo. Electricity generated from solar panels costs three or four times as much.

Dr. Sivoththaman is trying to change that.

He is the director of the university's Centre for Advanced Photovoltaic Devices and Systems (CAPDS), which last month moved into a 14,000-square-foot facility with equipment for manufacturing solar cells.

About 20 researchers are affiliated with the centre, and it is working with private companies, such as Waterloo-based Arise Technologies Corp., as well as government and international groups.

Scientists face two challenges. Solar cells must first absorb energy, then convert it to electricity. Find a better way to do either or both and the resulting electricity becomes cheaper.

The efficiency of a photovoltaic cell depends heavily on the material used.

About 90 per cent of cells are made with silicon, which has a theoretical limit of about 30 per cent overall efficiency, Dr. Sivoththaman says. Gallium arsenide is also used; it can operate at 40-per-cent efficiency under ideal conditions. But real-world performance of both materials is lower.

The Waterloo researchers are exploring the use of cadmium selenide, which promises better performance than either.

But cadmium selenide is less stable than silicon and could be toxic, Dr. Sivoththaman says. The problems will be resolved, he says, but it will take 10 to 15 years to produce commercial solar cells with it.

Much of the centre's work focuses on nanotechnology. By adding microscopic nanocrystals or nanowires - small enough to be measured in nanometres, or billionths of a metre - Dr. Sivoththaman expects the efficiency of solar cells can be improved significantly, by as much as 80 per cent.

The centre's researchers are close to being able to test cells using silicon nanowires, he says.

But their work won't stop there. Before the technology can become commercially viable, they have to figure out how to produce it in sufficient volumes.

"You can have a nice tool in your lab, but that might produce two wafers an hour," Dr. Sivoththaman says. Commercial production requires faster output.

In addition to fundamental research, the facility has set up pilot manufacturing lines to work out the challenges of mass production.

CAPDS is a "very different centre than what you normally find in universities, because we go one step farther than the laboratory or demonstration stage," Dr. Sivoththaman says.

Michael Collins, an associate professor of mechanical and mechatronics engineering at Waterloo, runs a rooftop test lab that allows CAPDS to try out new solar cell designs on campus.

Dr. Collins is also working on another approach to making solar cells more efficient - adding them to solar heating panels to create systems that produce both heat and electricity.

Mehrdad Kazerani, an associate professor of electrical and computer engineering at Waterloo, is working on the challenges of connecting solar-cell arrays to the power grid.

The electricity produced by solar cells is intermittent and variable, and thus requires conversion and conditioning before it can go into the commercial system, Dr. Kazerani says.

In addition, Arise Technologies is working with the centre to develop silicon tailored for use in solar cells.

Until recently, the solar industry relied on suppliers who served mainly the microelectronics sector. Microelectronics require purer and hence more expensive silicon than solar cells, says Ian MacLellan, Arise's vice-chairman and chief technology officer, and solar companies would get the leftover material that wasn't good enough for making computer chips. Arise is gearing up to produce silicon specifically for photovoltaic cells, aiming for better quality than the scrap the industry has relied on.

Arise is making use of CAPDS's pilot production facilities, Mr. MacLellan says. The company has its own solar-cell factory in Germany, he adds, "but that's a production facility," and running small batches with experimental materials would slow down commercial production, he says.

Other countries are treating solar energy as a strategic industry, Mr. MacLellan argues, and Canada needs to do the same.

"I think what Siva is doing is very, very strategic for Canada," he says. "It's a very, very good first step."