'Artificial leaf' eyed as holy grail in energy research

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Researchers are weighing a range of approaches to harness the power of photosynthesis to power engines.

Turbo-charging photosynthesis -- by which plants and bacteria turn sunlight into food and energy -- in an "artificial leaf" could yield a vast commercial power source, scientists said.

Photosynthesis is"unfortunately not very efficient," Anne Jones, assistant professor and biochemist at Arizona State University, told the American Association for the Advancement of Science meeting in Vancouver this weekend.

"In fact, all of our current fossil fuels are products of this process," she said. But photosynthesis efficiency "could be boosted to increase food yields or sustainable biofuel production."

The world's energy consumption is expected to surge by 100 percent in the next 40 years.

That is expected even as oil and gas reserves are being used up, according to researchers, who are weighing a range of approaches to harness the power of photosynthesis to power engines.

Scientists said that given the low efficiency of photosynthesis, the top theoretical yield for squeezing energy out of the process with major crops such as wheat or sugar beets would be about five percent.

But if efficiency could be forced up by even a few percentage points, they could be sitting on major biofuel production potential.

Jones said that when the enzyme that catalyzes steps in CO2 fixation, called Rubisco, becomes saturated, the process of producing carbohydrate slows down and that most absorbed light energy is lost as heat.

"When it's sunny, a plant's molecular machinery produces more electrons than the Rubisco carbohydrate-producing engine can handle, and a lot of those electrons are wasted," she said.

The situation, she said, was akin to a power plant unconnected to distribution grid, in which excess energy goes to waste.

"In this sense photosynthesis is like a badly connected electrical grid," Jones said.

Scientists want to harness the excess solar energy by transferring energy absorbed in a photosynthetic light harvesting cell via biological nanowires to a separate cell that will produce fuel.

Howard Griffiths, a Cambridge professor of plant ecology, is aiming to increase the efficiency of Rice's photosynthesis process of manipulating the Rubisco enzyme.

It is a bit like turbocharging a motor in mechanics -- but not so easy just yet.

Nature has already seen to it that some plants -- such as sugar cane and algae -- have a relatively higher-performance sort of Rubisco enzyme on hand thanks to a molecular mechanism called C-4.

This cell machinery may be able to be genetically engineered into rice to push crop yields higher.

Another take on tweaking photosynthesis came from Richard Cogdell, director of the Institute of Molecular Cell and Systems Biology at the University of Glasgow, Scotland.

It would use an artificial leaf to directly produce biofuel, using carbon dioxide and water. The biofuel would be a terpene, which "under the right conditions ... behaves like octane," said Cogdell.

"We are a long way from that, but we have the blueprint" that will get scientists at least half the way, he said.

"That is one of the grand challenges we are facing -- when oil and gas will run out, just to develop new ways of developing solar energy into fuel. We have a window of opportunity of 30 to 50 years," Cogdell said.