Nanotechnology provides 'green' path to environmentally sustainable economy

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As products made with nanometer-scale materials and devices spread to more industries and markets, there is a growing opportunity and responsibility to leverage nanotechnology to reduce pollution, conserve resources and, ultimately, build a "clean" economy, advises a new report from the Project on Emerging Nanotechnologies.

A "strong marriage" between nanotechnology and the principles and practices of green chemistry and green engineering "holds the key to building an environmentally sustainable society in the 21st century," concludes Green Nanotechnology: It's Easier Than You Think. Summarizing proceedings at a national American Chemical Society symposium and four workshops held in 2006, the new report was authored by science writer Karen Schmidt for the Project on Emerging Nanotechnologies, an initiative of the Woodrow Wilson International Center for Scholars and The Pew Charitable Trusts.

The report explores potentially beneficial links between nanotechnology – essentially, science and engineering practiced on the molecular scale – and green chemistry and engineering, which aim to minimize environmental impacts through resource-conserving and waste-eliminating improvements in processes and products. It concludes with recommendations for proactive federal policy measures to help the fast developing field of nanotechnology to "grow up" green.

The report cites examples of research progress toward using nanotechnology to accomplish environmental goals in combination with

commercial or other objectives. "With greater ability to manipulate matter and tailor properties, it should be possible to make products and processes with reduced toxicity, increased durability and improved energy efficiency," according to the report.

For example, James Hutchison, a University of Oregon chemist, uses DNA molecules in a novel process that holds promise for building nanoscale patterns on silicon chips and other surfaces. The experimental method saves materials and requires less water and solvent than the traditional printing – or lithography – techniques used in the deceptively resource-intensive electronics industry. Other researchers are investigating nanoscale approaches to replace lead and other toxic materials in electronics manufacturing.

Chemist Vicki Colvin and her Rice University colleagues have discovered that 12-nanometer magnetic nanoparticles can remove better than 99 percent of the arsenic in a solution, while their counterparts at Oklahoma State University have engineered nanoscale sensors that can detect pollutants at the level of parts per billion.

Nanotechnology has opened promising new routes for making inexpensive solar cells as well as improving the performance and lowering the cost of fuel cells, eyed as the energy source for cars and trucks of the future. At the same time, work at the nanoscale is leading toward tools for removing toxic materials and cleaning up hazardous waste sites.

"Nanotechnology potentially is a 'doubly green dream.' It offers us the opportunity to make products and processes 'green' from the beginning," explained Barbara Karn, an environmental scientist who helped organize the green nanotechnology programs while with the Project on Emerging Nanotechnologies. "It also allows us to substitute more environmentally-friendly chemicals, materials and manufacturing processes for older,

more polluting ones."

The report defines four categories in which nanotechnology applications and environmental interests intersect:

-- Fostering new nanotechnology-enabled products and processes that are environmentally benign – or "clean and green";
-- Managing nanomaterials and their production to minimize potential environmental, health, and safety risks;
-- Using nanotechnology to clean up toxic waste site and other legacy pollution problems; and
-- Substituting green nanotechnology products for existing products that are less environmentally friendly.

"We think the United States is on track to be a global leader in green nanotech," said David Rejeski, director of the Project on Emerging Nanotechnologies. "The country's research and development portfolio should be directed toward this goal. We believe green nanotechnology can not only help protect the environment but also be a source of American jobs and company profits in the future."

Looking ahead, beyond legacy environmental problems of today, the report suggests that the most effective approach to protecting the environment would be to "develop green nano policies that actively promote pollution prevention."

Ranging from developing metrics for evaluating bottom-line environmental impacts to using federal procurement to foster demand for green nanoproducts, the recommended policy steps outlined in the report would help to ensure that the $8.3 billion taxpayer investment in nanotechnology, since the U.S. National Nanotechnology Initiative was established in 2001, pays off for the country and the environment.

"We are on an unsustainable path," said Paul Anastas, director of the American Chemical Society's Green Chemistry Institute. "It is not as though nanotechnology will be an option; it is going to be essential for coming up with sustainable technologies."

Source: Project on Emerging Nanotechnologies