

more conventional fixed-mount systems.

"On a typical sunny day, the system ramps up slowly as the sun rises," Miller said. "The [rows of solar panels] track the sun from east to west and [the plant] achieves its maximum output by around 9:00am [depending on the season] and remains [at that output level] until 3:00pm when it begins ramping back down, shutting down at sunset."

Output would drop during cloudy or rainy periods.

The current top solar power plant worldwide, Solarpark Pocking, began operating in April 2006 on a former military base in Bavaria. With a peak output of 10 MW, it has 58 000 PV modules and generates electricity for about 3000 homes.

Miller said the Serpa plant will store no power and that the electricity it generates will be delivered to the Portuguese power grid. Construction of an electric substation on-site is under way.

The plant was designed with a life expectancy of at least 25 years, and as the modules wear out, they will simply be replaced. They'll need only regular clean-

ing to maintain peak efficiency—and the task won't require a crew with industrial ladders, as the modules are mounted only about five feet from the ground.

The plant is expected to reduce greenhouse gas emissions by more than 30 000 tons a year compared with equivalent fossil-fuel energy generation.

Although use of solar radiation to generate energy is highly desirable for many environmental reasons, the process is still too costly for solar power plants to replace other traditional energy sources on a mass scale worldwide, said Piero dal Maso, co-CEO of Catavento Lda. PV cells represent much of that cost, he added; presently no automated system exists that can manufacture them, and the silicon used in their production is also expensive.

When the Serpa plant is completed, it won't be the hillside's only occupant. Some 500 sheep now roaming the property will remain there, but they'll do more than just look picturesque. "We don't want bushes growing up over the modules, and the sheep will eat them," dal Maso said.

Karen H. Kaplan

been done." When assessing the health risks of nanoparticles, size matters because the particles are small enough to cross biological boundaries, such as the blood-brain barrier and the placenta, that other particles cannot, he said.

Maynard's first recommendation in the report is a call for "top-down authoritative oversight of strategic risk-based research within the federal government." He also calls for shifting nanotechnology risk research to "federal agencies with a clear mandate for oversight and for research into environment, health, and safety issues."

While most federal nanotechnology funds go to NSF and the Department of Energy, Maynard said the EPA, the National Institutes of Health, and NIOSH should be doing the risk research.

The report also calls for "adequate funding" directed specifically at risk research, which Maynard puts at about \$50 million a year. "If we're going to see business succeed with nanotechnology, we've got to see the safety issues dealt with up front," he said.

Clayton Teague, director of the government's National Nanotechnology Coordination Office, said the government's investment in risk research in 2005 was \$35 million and he projects spending of \$38 million in 2006. "We've been funding risk research since the inception of the National Nanotechnology Initiative in 2001. Since that time it has grown steadily." Maynard acknowledges the \$38 million figure in his report, but claims the number is vague and "no detailed information was released on the research being supported by this funding." Regardless, Maynard said, it is not enough. Teague said the NNI is completing a risk-related "research needs" document that will look in detail at all the risk research being done throughout the government, and recommend what new work needs to be done.

Business groups are pushing for more federal risk research to lessen their liability and reduce the likelihood of a public backlash against nanotechnology if there is a problem with a product in the marketplace. Paolo Gargini, director of technology strategy for Intel Corp, said Maynard's report was "an important contribution to building much needed consensus around the need for focused research into the implications ... of nanotechnology." Intel, he said, believes there is a need for more federal research "devoted to studying the environmental, health, and safety dimensions of nanotechnology."

The report calls for a short-term research plan to look at products already in

Nanotech risk research needs strategy, money

Physicist Andrew Maynard sat at the head table in a packed conference room at the Woodrow Wilson International Center for Scholars in Washington, DC, and unscrewed the lid from a jar of calcium powder containing nanoparticles. A puff of the powder rose into the air as he lifted the lid.

"Is it safe to breathe this in?" he asked the audience. He held up a jar of face cream containing carbon-60, or buckyballs. "You put this on your face. Is it safe, or not? I don't know."

Nobody else knows either, Maynard said, and that is the reason he is calling on the federal government to develop a research strategy to determine the health and safety risks of the emerging field of nanotechnology. In his new Wilson Center report, *Nanotechnology: A Research Strategy for Addressing Risk*, Maynard recommends that \$100 million be spent over the next two years on nanotechnology risk research.

Calculating how much is now being spent to determine the potential dangers of nanotechnology is difficult because the funding is spread across several agencies, he said, but he believes the annual amount is about \$11 million. Maynard, the chief science adviser to the Wilson Center, said it is critical to develop an overarching strategy to assess the safety of the myriad forms of

nanoparticles before widespread health problems develop, not after.

To give an idea of the scope and immediacy of the problem, Maynard points to a recent study by Lux Research, an investment advisory company. That study says more than \$32 billion worth of products using nanotechnology were sold worldwide in 2005. Government and private US investments in nanotechnology R&D have already reached \$3 billion, and NSF, a major sponsor of nanotech research, predicts that the global market for products and services using nanotechnologies will reach \$1 trillion by 2015.

"The fundamental issue is, we have risks we haven't seen before," said Maynard, an aerosols researcher who formerly worked on nanotechnology safety issues for the National Institute for Occupational Safety and Health (NIOSH). "Nanoparticles do behave differently in the environment and in the body than other things we've faced in the past."

"Are there risks from nanomaterials? In some cases, yes, in some cases, no," said Jeremiah Duncan, an American Association for the Advancement of Science fellow working in the US Environmental Protection Agency's office of pollution prevention and toxics. "But for the most part, we don't know because the bulk of the research has not

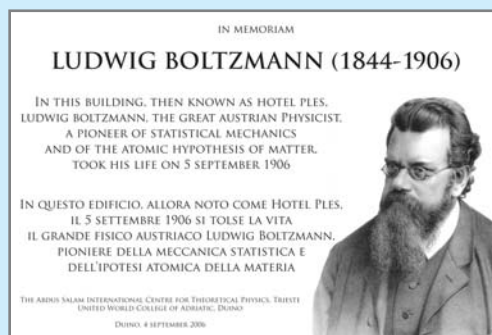
Boltzmann honored on death centenary

This month, which marks the 100th anniversary of his death, the Austrian physicist and mathematician Ludwig Boltzmann is being honored with a commemorative plaque in Duino, Italy. The plaque is to hang in the hotel—now a college—where Boltzmann committed suicide on 5 September 1906 while on vacation with his family.

The plaque is the doing of the International Centre for Theoretical Physics (ICTP) in nearby Trieste and its director, Kathepal Sreenivasan. "We are the physics center in the vicinity," he says. "And Boltzmann had a tremendous impact on me personally." Sreenivasan recalls being about 19 years old when he first learned about Boltzmann: "He had to struggle for recognition. He killed himself at least partly because he couldn't come to terms with the criticism of his work. I resolved that I would never allow the criticism of my work to destroy my creativity."

A ceremony at the plaque hanging includes talks by physicists and local dignitaries. ICTP is also hosting an exhibition about Boltzmann's life and work.

Toni Feder



the market—everything from the calcium powder to cosmetics to neck-support pillows filled with silver nanoparticles. Maynard also calls for international coordination of risk research, establishing a joint government-industry research institute, and creating an interagency oversight group with the authority to coordinate and direct the risk research program.

Given the budget constraints plaguing the entire federal government, Dun-

can and other environmental safety experts doubt there will be new money for nanotechnology risk research. And Teague said creating "one über agency" to regulate research throughout the government would be difficult to implement. "But [Maynard's] report is a thoughtful analysis of what's being done and where things are going," he said. "There needs to be a solid strategy for moving forward."

Jim Dawson

NASA aeronautics lacks money, relevance, NRC says

For more than a year, NASA has been taking flak from legislators and scientists for ongoing cuts to science missions as the agency shifts its priorities to a new manned space vehicle and a goal, mandated by President Bush, of returning humans to the Moon and eventually sending them to Mars. Now concern is growing on Capitol Hill and in the aeronautics industry that NASA's aeronautics program, represented by the first "A" in NASA, is being underfunded to such an extent that it might be, in the words of a recent National Research Council report, on "a glide path to irrelevance."

Two recent NRC reports, one a decadal survey of civil aeronautics and the other a study of the aeronautics programs at NASA, raise serious concerns about the administration's cuts in aeronautics funding and the space agency's failure to restructure the program to reflect its shrinking budget. The decadal

survey, which offers a detailed list of "51 challenges" NASA should address so as to maintain its aeronautics program, notes that funding has been "severely cut during the past few years, falling from over \$1 billion in fiscal year 2004 to a proposed \$724 million in fiscal year 2007."

The budget cuts are even worse than that, Michael Romanowski, a representative of the Aerospace Industries Association of America, told the space and aeronautics subcommittee of the House Committee on Science in July. Funding for NASA's Aeronautics Research Mission Directorate was \$1.54 billion in FY 1994, he said, and 13 years of consistent cuts have resulted in a more than 50% reduction in federal support.

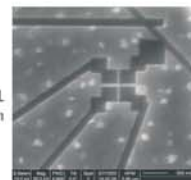
The NRC study on aeronautics challenges faced by NASA says the space agency's aeronautics program is "overshadowed in resources, managerial attention, and political support by the

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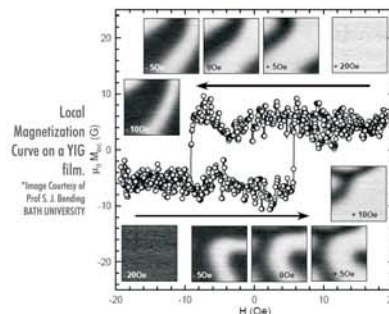
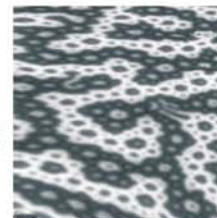
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