

New neutron source aims to be top in energy and environmental stewardship

From windmills to green roofs, the European Spallation Source may be setting a trend for major scientific facilities.

Renewable, recyclable, responsible. That is the motto of the European Spallation Source (ESS). The ambitions to build the facility to be energetically self-sufficient and to have as small a carbon dioxide footprint as possible are, at least in part, what landed the project for Lund, Sweden, last year.

The ESS will be the world's most powerful neutron source. "We will deliver a factor of five higher in power, and a factor of six in neutrons per proton, giving 30 times the neutron intensity of the SNS [the Spallation Neutron Source in Oak Ridge, Tennessee]," says ESS director Colin Carlile. The incident proton pulses that hit a target and knock out neutrons for experimental use will be longer at the ESS than at other sources—2 ms compared with about 1 μ s at the SNS, the Japan Proton Accelerator Research Complex, and ISIS in the UK. Longer pulses are the best route to neutron economy, says Carlile. "With short pulses, you have to cut down the intensity to maintain sharp pulses. With long pulses, you basically exploit the natural time it takes for neutrons to slow down." Adds Hague-based Peter Tindemans, an independent adviser on science, technology, and innovation policies and chair of the board of the ESS Preparatory Phase, "It's becoming clear that long pulses can do almost everything short pulses can do, and many other things too."

Now, two decades in the planning, and after a failed bid to build it in 2002, the ESS finally looks like it will go forward (see PHYSICS TODAY, June 2008, page 22). A refinement of the earlier ESS design is under way. Construction is expected to begin in 2013, the first neutrons would fly in 2019 with 7 of the 22 planned instruments online, and the machine would be fully operational in 2025. Half of the funding is being guaranteed by Sweden, Norway, Lithuania, Estonia, Latvia, and Denmark, which is coordinating the facility's data management. Pledges from several other countries bring the commitments to nearly 90% of the total cost, which is capped at €1.5 billion (\$2.1 billion). Although Germany, Italy, France, and Spain are partners in the ESS, smaller countries have taken the leading role. "It is a significant



The European Spallation Source, an array of buildings that includes the 600-meter-long linear accelerator, target station, and curved instrument buildings, will be sited in Lund, Sweden. It and the nearby MAX IV synchrotron light source (large circular building) form part of a "science corridor" that extends northward from Hamburg, Germany, where the

European X-ray Free Electron Laser is being built, and is intended both to cultivate local use of the science facilities and to position the region to financially exploit the increased visitor traffic the facilities bring. (Montage courtesy of the European Spallation Source.)

development in European science policy," says Tindemans. "It shows that there are some limits to the predominance of the bigger countries."

Proven technologies

Among the advanced technologies for science that the facility will incorporate are neutron guides, which, Carlile says, "save space so you can fit in more instruments." Neutron guides were used in the Institut Laue-Langevin, a continuous neutron source in Grenoble, France, in the 1970s but have never been used systematically on pulsed sources, he adds. Because of the shortage of helium-3 (see PHYSICS TODAY, October 2009, page 21), the ESS is also looking into thin-film boron and other alternatives for detecting neutrons. As for computers and remote control, says Carlile, "We have to dream up what will be around in 10 years. We have to hit the moving target relating to instrument control." For the most part, the ESS will use proven technologies. "Because 5 MW is extremely powerful. You cannot afford to take too many technological risks," he says.

Likewise, the technologies to be implemented for sustainability purposes will be tried and true. "When I went to

the research ministries in different countries, the science was interesting to them. But the thing that made them sit up was when we talked about our sustainability plans," says Carlile. Still, he adds, sustainability cannot come at the cost of the ESS's scientific prowess. "We have to reassure our funders that we are not doing research into energy sustainability. If [the funders] feel it's the tail wagging the dog, they won't like it at all."

The biggest energy-saving measure will be capturing and recycling excess heat. "You put 40 MW in and get 20 MW out in waste heat," says Richard Bengtsson, senior project manager at the global E.ON, one of four energy companies that ESS planners are working with. "All that is typically just vented out to the air."

"You see all these instances where people are heating and cooling at the same time," says ESS energy manager Thomas Parker. "We will try to use heat from things that are too hot to heat things that are too cold. If we do this right, we won't have to build boilers. We hope we won't have to build cooling towers either. I have a strong vision that we will never heat and cool at the same time."

Referring to the "renewable, recyclable

A voice for Africa's physicists

On 12 January in Dakar, Senegal, some 110 physicists from 20 African countries joined with 10 national African physical societies to launch the African Physical Society with the help of several international physical societies (see photo). The AfPS takes the place of a combined math and physics association. "This will give more of a focus on physics and give us a continental voice," says Akin Adedoyin, an atmospheric physicist at the University of Botswana and the new organization's general secretary.

The AfPS will be an umbrella "so we can find out what others are doing and help each other," says Adedoyin. "Let's say I have some equipment and my colleague in Rwanda wants to use it. We can find a way to bring him to Botswana to do research." On a more formal level, the AfPS will set up commissions to explore physics aspects of issues such as energy, water, and climate, adds physicist Paul Wofo, vice dean of research and cooperation at the University of Yaoundé I in Cameroon and one of five AfPS vice presidents. The new society will also work to increase funding for physics research and training and to form networks of physicists across the continent who could, among other things, collaborate to fabricate and distribute research equipment at low cost, train secondary-school teachers, and attract international physicists to spend a couple of months teaching in Africa.

The AfPS has adopted the pre-existing *African Physical Review* as its official publication, and the society plans to offer members such benefits as fee waivers for attending conferences. The number of physicists in Africa is unknown, but the bulk are in Nigeria, Egypt, Tunisia, and South Africa. "Apart from those," says Adedoyin, "it's not a large community."

Unlike its predecessor, the AfPS allows both national societies and individuals to be members. Indeed, says Adedoyin, "we encourage countries that do not have national societies to have them, so Botswana will establish its own physical society."

A key aim of the AfPS, Adedoyin says, is to gain the observer status that its predecessor organization had in the African Union. "That will give us a platform to interact with policymakers, so the voice of physicists could be heard." For example, he says, "many governments do not appreciate basic sciences. We need a forum to drum into the government the importance of funding science. If we do not have that voice at the continental level, it can be very difficult."

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AFRICAN PHYSICAL SOCIETY

ble, responsible" motto, Parker notes that the most basic aim is to be responsible—that is, to use as little energy as possible. In line with the European Union's 20-20-20 initiative to reduce energy consumption and greenhouse gas emissions by 20% and to have 20% of energy come from renewable sources by 2020, the ESS team is working on reducing the design power needed to 32 MW.

"Low-hanging fruit"

"Our goal for recapturing heat is 60%," Parker says. Some will be recycled in-house, but the plan is to feed most of it into Lund's district heating system. "This is the low-hanging fruit," says Bengtsson. "You invest in heat exchangers to move heat, but you get paid for the heat." The waste heat from the ESS will provide a quarter to a third of Lund's heat demand of roughly 1 TWh, according to Mats Didriksson, who is in charge of business development at Lund Energy Group. "It's tremendously important to both parties."

Redirecting waste heat from the ESS also means, says Didriksson, "that we can substitute gas fuel with waste energy and reduce emissions in the whole system." Adds Lars Lavesson, an archi-

tect from Lund University who heads up licensing and planning for the ESS, "It's not just a question of morals. It is highly economical." In total, says Parker, the energy-saving measures could amount to 7.5% of the construction costs but will save money in the long run.

The ESS and Lund Energy Group are looking into storing hot water underground in limestone aquifers. "If you go down about 70 to 100 meters, the ground looks like Swiss cheese," says Didriksson. "Put the water there, it works like a storage facility. In the winter, when you have demand for the energy, you pump it up."

The ESS plan also calls for buying windmills. In fact, the idea for the ESS's focus on sustainability was hatched about two years ago around the idea of "owning our own means to produce power," says Carlile. He and colleagues "were sitting around a coffee table, drawing on paper napkins, and we realized that would give us more control of the research budget. It factors out the fluctuations in energy costs." Carlile and his team calculate that "25 state-of-the-art windmills, for about €125 million, would supply all the power we

need." The ESS will feed power into the public power grid and take it out, according to need. Another advantage of buying windmills, notes Parker, "is that we're not just shifting who uses renewable energy. If we bought renewable energy, then the utilities could just sell other customers more energy from non-renewable sources."

Energy-conscious culture

Besides the big-ticket measures, the ESS is also looking at smaller ways to improve energy efficiency and otherwise be environmentally conscious. Parker is spending a year at the SNS to get ideas for the ESS. "I spend a lot of time going out and feeling things, finding stuff that is hot. It's a tactile exercise," he says. "I'm also trying to build up an understanding of flows—benchmarking where the energy is coming from and going. This is nothing but a big plumbing project, as someone at the SNS put it to me."

Among the smaller-scale measures the ESS is either adopting or considering are green roofs—a mat of sedum, a succulent, which, Lavesson says, will not only act as an insulator but also help control flooding and water runoff

caused by introducing buildings and parking lots. The ESS is being built on agricultural land, next to the MAX IV synchrotron light source now under construction. "We are going to plant trees and put in dams to delay storm water drainage. We will probably make it better for wildlife," says Lavesson.

In the construction process, Carlile says, "we will impose certain environmental standards on our suppliers. We will use nontoxic materials. We will design from the outset to make decommissioning as easy and inexpensive as possible." The little things add up, he says. "And they have a knock-on effect: They send a signal to staff that we are

energy conscious and that the profligate use of energy is not acceptable. They provide a culture which underlies everything."

In aiming for zero negative environmental impact on the planet, Carlile says he feels "comfortable putting a ring around the facility and even the staff the moment they leave their front doors. We can compute their energy use and include it in the equation." And he'd like "to include the carbon dioxide emissions cost of bringing users here, but I am not yet sure I can deliver." One item for which there is no environmentally clean solution is disposal of the target at the heart of the neutron source,

which will be radioactive.

When the SNS was being designed in the late 1990s, "we attempted to build in some rudimentary sustainability," says SNS operations manager Frank Kornegay. "But at the time, any additional costs associated with energy-efficient this or reduced that was considered fair game to cut to meet the budget."

Now, Kornegay adds, "the science community seems more interested in energy efficiency. And it's not always more expensive. The ESS will build in their goals upfront. That is the way to go. It forces engineers and architects out of their comfort zone and frees them to be really innovative." **Toni Feder**

Roundtable participants find near-consensus on free access to results of publicly funded research

Publishers and subscribers urge agencies to freely distribute scientific journal articles based on federally sponsored research.

With the recommendations of an advisory committee on scientific publishing in hand, the White House Office of Science and Technology Policy (OSTP) has begun moving toward a policy that will require all federal agencies to provide free access to all scholarly articles based on the research they fund. One outstanding question that will have major economic ramifications for the publishers of scientific journals is just how long an exclusivity window publishers will have before significant contents of their journals become freely available on online platforms.

Late in January OSTP staff began poring over the 500 or so comments they received in response to the agency's request for public input on the issue of "public access," as it is called. OSTP also is considering a 30-page report (<http://science.house.gov/press/PRArticle.aspx?NewsID=2710>) crafted by the advisory committee convened by the House Committee on Science and Technology. Known as the Scholarly Publishing Roundtable, the panel sought to bridge a divide that has long existed between publishers, which charge thousands of dollars for annual subscriptions to many of their journals, and their subscribers, which typically comprise the libraries of research universities. The journal industry is enormous, with \$8 billion in annual revenues worldwide, according to one estimate used by the roundtable. The numbers of journals and their publishers are also immense—25 400 and 2000, respectively, by one estimate. The costs of accessing such a volume of information, the report notes, "are challenging

the strained budgets of universities and their libraries," while the broader public has little access to the literature.

The 14 roundtable participants were drawn from all sides of the issue—librarians, university provosts, academic researchers, and publishers (including Fred Dylla, executive director and CEO of the nonprofit American Institute of Physics [AIP], which publishes PHYSICS TODAY). Elsevier, the largest of the commercial publishers, with about 2000 titles, had a seat, as did the Public Library of Science (PLOS), a relatively new publisher that uses an alternative business model known as open access; it provides immediate free access to its journals and charges article authors a publishing fee. The PLOS representative, director of publishing Mark Patterson, said that he could not fully endorse the roundtable's consensus report, a position that was also taken, for different reasons, by roundtable member and Elsevier vice chairman Y. S. Chi.

A lengthy process

The public-access movement began in earnest more than a decade ago when Harold Varmus, then director of the National Institutes of Health, pushed for the agency, which is by far the largest federal funder of basic research, to offer free online access to all the published work of NIH-funded investigators. The rationale was that taxpayers shouldn't have to pay to see the results of the research that they paid for. Varmus later cofounded PLOS, which embodies the open-access publishing model, and he continues to chair the board of that nonprofit organization. He is also one of

three cochairs of the President's Council of Advisors on Science and Technology, which works closely with OSTP.

Following years of back-and-forth between NIH and biomedical journal publishers (see PHYSICS TODAY, December 2004, page 34), Congress finally mandated public access for that agency. Since mid-2008 all articles by NIH grantees automatically become freely available from the PubMed Central archive operated by the National Library of Medicine (NLM), but not before a delay, or embargo period, of up to one year after journal publication. Other federal R&D funding agencies haven't followed suit, in part because there is less public demand for non-health-related research results. But other agencies also don't have a resource like the NLM, which has an annual budget of \$350 million. The roundtable report points out that to achieve public access, agencies may need to establish their own public databases in-house or with university libraries, publishers, or other external partners. Either approach will involve collaboration among all parties, the report emphasizes.

The public-access policymaking process begun by OSTP occurs against a backdrop of ongoing pressure from President Obama for agencies to take extraordinary steps to open their data and their decision making process to public scrutiny. An open government directive issued by Office of Management and Budget director Peter Orszag in December, for example, ordered each federal agency to make public within 45 days at least three "high-value data