

pressurization typically lasts for only a few hours. By contrast, the injection of large volumes of CO₂ over many years will steadily build pressure in the reservoir, according to the NRC committee and Zoback.

But a breach in the sealing cap doesn't necessarily mean that the CO₂ will return to the biosphere, Litynski says. "Subsurface geology is very heterogeneous, and potential storage sites typically have multiple sealing units . . . above the primary seal, providing additional protection against fluid migration."

Ruben Juanes, associate professor of energy studies at MIT, believes that seismicity, though an important consideration, does not represent the death knell for geologic sequestration. "While I

agree that these risks are serious, I disagree with the authors' claim that they will likely render CCS unsuccessful," he says. The quakes attributed to fluid injection have been at magnitudes below the damage threshold, Juanes notes. The evidence presented by Zoback and Gorelick is anecdotal and "does not justify the conclusion that moderate-size earthquakes will threaten the seal integrity to the point of rendering CCS unsuccessful. In particular, [Zoback and Gorelick] support this sweeping statement with a reference to some lab experiments, rather than field experiments, on granitic rocks, which would never be used as a host rock for CCS."

In the big picture, seismicity pales in comparison to cost as an impediment to the adoption of CCS, says Rachel Clee-

tus, a climate economist with the Union of Concerned Scientists. "Honestly, the challenges to CCS are so significant on the economic front that this is just going to be one more thing that makes people question the risk of going down that path versus other options that are readily available and much less risky, such as wind and solar," she says.

"The difficulty is that carbon isn't priced in a meaningful way," adds GeoScience's Batchelor. "Until carbon has a price, it bears down on the renewables, and it bears down on CCS. And the US, UK, and most European governments are not going to put their industries at a competitive disadvantage by saying we insist you do [CCS] and double the price of power on a unilateral basis."

David Kramer

Germany differentiates its universities

Winners and losers in a bid for money and prestige say the process has helped universities plan for the future. Many also see the heightened competition as good for research.

The big surprise in the second and final round of Germany's Excellence Initiative, which aims to propel a few of the country's universities into the international top tier, was that three of the big winners from the first round lost their "elite" status. Results were released on 15 June.

Jaws dropped with the news that the Karlsruhe Institute of Technology (KIT)—

formed beginning in 2006 under the Excellence Initiative in a pioneering merger of the University of Karlsruhe, funded by the state of Baden-Württemberg, and a federally funded research center of the Helmholtz Association—failed in its renewal bid. The Universities of Göttingen and Freiburg are also licking their wounds. In a surprise to some, the University of Bremen, a small campus, won

its bid with a research cluster of excellence—a collaboration, often across departments or institutions, intended to become a leader in a particular area of research—in marine environmental studies and a graduate school in social sciences. And joining the ranks of excellence are two universities from the former East Germany: the Humboldt University of Berlin and the University of Technology Dresden.

German researchers like to say that it takes a fortune and a few hundred years to create a university like Harvard

HUMBOLDT UNIVERSITY OF BERLIN



A historical machine test bed (left) is now a cafeteria at Humboldt University of Berlin, a big winner in the final round of Germany's Excellence Initiative. The university's physics department is at the back right, and an administrative and teaching center is at the left. Graduate students (below) display a research satellite they built at the University of Technology Dresden. The two universities are the only ones from the former East Germany to win "elite" status.



KARSTEN ECKOLD, UNIVERSITY OF TECHNOLOGY DRESDEN

or Cambridge. With a total of €2.4 billion (\$3 billion) to award over the next five years, the initiative has nowhere near the money or the time to create a world-leading university, but as evidenced by the two-part first round (see PHYSICS TODAY, January 2007, page 28, and December 2007, page 30), the new money and new form of competition are leading to more differentiation among the country's universities.

Three funding lines

A total of 45 graduate schools and 43 clusters of excellence—with close to a dozen of each in physics-related fields—won funding. Those two lines of funding were distributed among 44, or about half, of Germany's universities. On average, clusters get €6.8 million and graduate schools get €1.6 million a year.

Universities with at least one cluster and one graduate school could vie to have their institutional strategies recognized. That is the most prestigious line of funding within the initiative, and the awards average €12 million a year. Joining Dresden, Humboldt, and Bremen as newcomers to that "elite" status are the University of Cologne and Eberhard-Karl University of Tübingen. With re-

peat winners—the Technical University of Munich, Ludwig-Maximilians University (LMU) in Munich, Heidelberg University, RWTH Aachen, the Free University of Berlin, and the University of Konstanz—the total is now 11. As of press time, explanations and the amount of each award were expected imminently from the German Research Foundation, which oversees the clusters and graduate schools; a government advisory body, the Wissenschaftsrat, administers the institutional strategies.

Although this year's competition marks the end of the Excellence Initiative, new winners will have a chance in five years to compete for renewal. "It does not make sense for universities to permanently have to think about their structures and change things," says physicist and University of Cologne president Axel Freimuth, "but we need to think about how to sustain the improvements."

Beyond money

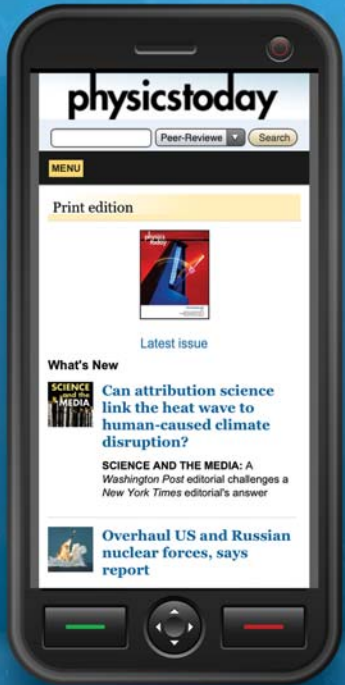
Overall, the Excellence Initiative money is not that much—the institutional strategy awards, for example, may add a small percentage to a university's budget. But the money is flexible. Uni-

versities use it to hire people whose work may not fit into any given department, to hire young researchers in more autonomous positions than is the norm in Germany, and to offer more money when recruiting or retaining faculty members; many of the "elite" universities also set up frameworks to attract world-class visiting faculty. But the impacts of the Excellence Initiative go beyond money.

The initiative has spurred stronger collaborations between researchers at universities—winners in the competition or not—and the national research centers of the Max Planck Society, the Fraunhofer Society, the Helmholtz Association, and the Leibniz Association. The initiative's graduate schools are meant to be "crystallization points" for replacing a traditional model of apprenticeship, and that more student-centric environment is spreading, says the German Research Foundation's Klaus Wehrberger. The mantle of excellence may attract better undergraduate students, although evidence for that is anecdotal. In Germany, some 85% of undergraduates study at a university near where their parents live.

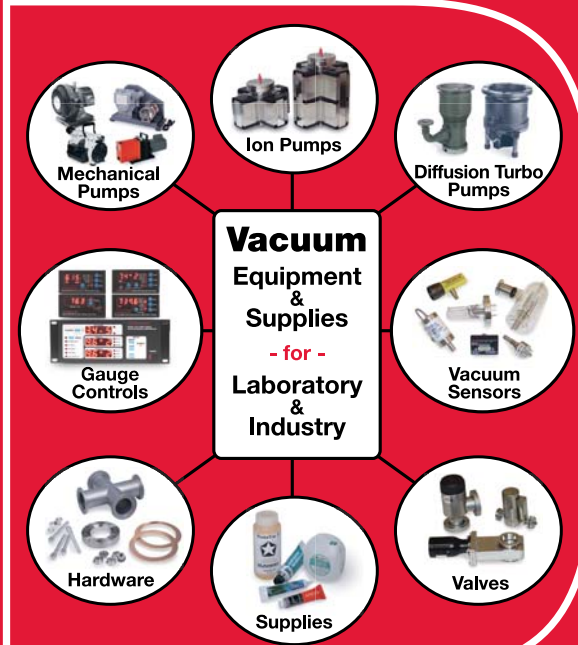
Having returned to LMU in 2009 after five years away, Ulrich Schollwöck,

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a theoretical physicist, says he could see “all the more clearly” the differences that the Excellence Initiative has made. LMU’s four clusters of excellence, two of which are in physics, created “an enormous burst of creativity and influx of money,” he says.

Mobilizing universities

Universities that are successful in the Excellence Initiative also find it easier to attract other money and to form industrial partnerships. With the creation of KIT, third-party contributions doubled over five years to about €340 million annually, says institute president Eberhard Umbach. “And industry is queuing up to cooperate with us. We have several companies that want to build labs on our campus.” KIT’s international contacts increased 10-fold. In the latest round of the Excellence Initiative, the institution’s strategy got high marks, but its sole cluster of excellence, in nanosciences, was not renewed, spelling the end of KIT’s eligibility for “elite” status. Despite that setback, Umbach says, “we will keep on the success track.”

For the University of Technology Dresden, which in the first round won a cluster and a graduate school, hitting the jackpot this time was “crucial,” says chemistry professor Rainer Jordan. “Basic funding from the state of Saxony was low here, so the impact of the initiative is important.” Also important, he says, is that the awards were not politically motivated. They were “based not on the fact that Dresden is in the East but on the quality of our proposals.” Dresden had its cluster on regenerative therapies renewed, and it won a new cluster in advanced electronics and a new graduate school in biomedicine and bioengineering. The awards benefit the university as a whole, says Marlene Odenbach, who coordinated Dresden’s institutional strategy proposal. “It gives a boost to our reputation. We are much more visible now.”

More than anything, though, the initiative has mobilized universities to think about where they are and where

they want to go. “In terms of strategy building within universities, [working on proposals for] these last two years [has] been extremely fruitful,” says Georg Krausch, a physicist and president of Johannes Gutenberg University Mainz. Although Mainz lost in its bid for an institutional strategy award, it got a new cluster in nuclear physics. And, he says, “the university has changed. The whole university supports its goals. I believe that overall, research has benefited from the initiative.”

Polarization

How much differentiation is really occurring among German universities? Schollwöck notes that the LMU nanoscience cluster, which got a thumbs up, is not so different from the one at KIT that was nixed. And he says that while a university labeled excellent may attract better people, “there is overlap [in quality], for example, with our neighbors in Augsburg who don’t have that label.” It can be a problem, says Krausch, when people outside of Germany say “11 universities are elite and the others are not. Why, then, should we cooperate with Mainz?” Krausch blames the media for spreading misleading interpretations that “shape our image in the international community. Those German research universities that do not belong to the group of 11 now need to convincingly stress the academic strengths they have been developing for decades or even centuries.”

Not surprisingly, the increased competition among universities—and among fields within each university—has downsides. With its institutional strategy award, Freimuth says, Cologne is “making a big attempt to be integrative so that it’s not that 20% get something and 80% are left behind.” But the Excellence Initiative “has caused some polarization” between those in fields that did win awards and those that did not, says Dieter Schmeisser, a physicist at the Brandenburg University of Technology Cottbus. “There are fields that

are not in the club, so to speak.” And, he says, “a lot of smaller universities don’t have a chance to participate” in the competition because they lack access “to the same large scientific communities” available in Dresden, Berlin, or Munich.

By extension, the differentiation would eventually lead to separate teaching and research institutions. That would be a good thing, says Freimuth. “A system has grown in Germany which has nearly 100 universities that all claim to be research universities. Can we support that?” Still, he says, “I don’t like the ‘excellence’ phrasing. It’s more a question of developing different profiles for different institutions. And then in your profile, you should try to be excellent.”

Differentiating among universities “starts out on the psychological level,” says Schollwöck. “In the past it was not acceptable to advance the argument that some universities are better than others.” There are obviously losers in the Excellence Initiative. “But I would argue that this is the price for any reform. Progress rests on creative destruction.”

Ideas, a natural resource

The Excellence Initiative “has been a huge effort for the entire system, and we can’t do such an impulse too often,” says the German Research Foundation’s Wehrberger. “We hope that impulse will change a lot in the right direction, and that other more continuous mechanisms can take over.” Keeping the additional funding in the system, he adds, “is necessary to keep Germany strong in an increasingly competitive world.”

“That is particularly important for Germany, which doesn’t have much else in resources besides good education and good research,” Wehrberger says. “We don’t have gas or oil. Coal is out. We don’t want nuclear power, so we need good ideas.” Just how money may be distributed in the future, he says, “will be debated a lot in the next few years.”

Toni Feder

Costs for polar-orbiting weather satellites climb again

Delay in launch of spacecraft is expected to cause deteriorated forecasts.

Fed up with an escalating price-tag and schedule delays on the next-generation polar-orbiting weather satellite system, Senate appropriators have ordered that the development of weather satellites—and the \$1.6 billion

budgeted for it—be moved from the National Oceanic and Atmospheric Administration to NASA. In the report that accompanied the Senate bill, the Appropriations subcommittee, chaired by Barbara Mikulski (D-MD), asserted that

removing NOAA as “middle brokers” in the development and acquisition of weather satellites will save \$117 million in fiscal year 2013. Noting that NASA has long managed the acquisition contracts for NOAA satellites, the report said the additional layer of bureaucracy that NOAA creates “only adds to the communication disconnect and compli-