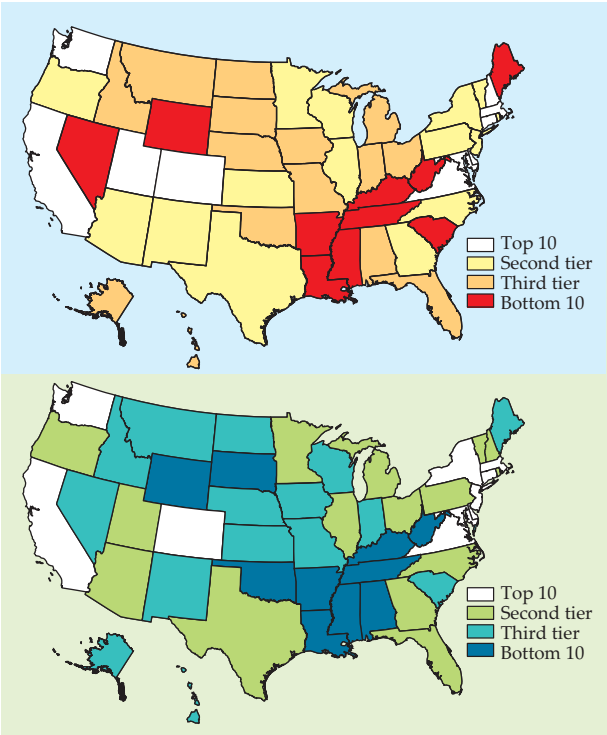

US states are ranked according to the economic impact of their technology investments. Shown above, the 2010 State Technology and Science Index (Milken Institute, Santa Monica, California) evaluated states' technology commercialization output; shown below, the 2010 State New Economy Index (Information Technology and Innovation Foundation, Washington, DC) also covered a state's ability to adapt to a high-tech global marketplace.

from the state and from local technology companies EMC and Cisco.

In 2010 Delaware climbed from 14th in 2008 to 10th on the Milken Institute index and from 7th in 2007 to 6th on the ITIF index. This year the University of Delaware begins construction of a 1.1-square-kilometer science and technology campus on the site of a shuttered Chrysler assembly plant. "[The campus] is our next 100 years of growth," says university president Patrick Harker, a former engineering and business professor. "Our plan for building out the property aligns with the university's R&D priorities: energy and the environment, life and health sciences, and national security and defense."

Finding the sweet spot

Like Delaware, Utah moved up in the 2010 rankings, jumping three spots to 5th on the Milken Institute index and one spot to 12th on the ITIF index. Much of the credit is given to the Utah Science Technology and Research initiative, established by the state government in 2006. Since then, the initiative has spawned 20 startup companies and 2300 new jobs, thanks to the hiring of 40 out-of-state academic researchers who have brought in more than $66 million in research grants.

A key feature of the initiative was hiring "new people with new ideas that match existing strengths," says Thomas Parks, University of Utah vice president for research. Those strengths include space environment sensors and agriculture at Utah State University and imaging and bioengineering at the University of Utah. In its latest initiative, Utah looks to ramp up research and innovation of clean-coal and renewable-energy technologies by forming a research triangle among the University of Utah, Utah State University, and Brigham Young University and strengthening collaborations with neighboring national laboratories in Idaho, New Mexico, and Colorado.

"High-ranking states are knowledge driven, investing in higher education and attracting managerial and tech firms," says Scott Andes, a research analyst at ITIF. "Low-ranking states are almost exclusively resource driven; they continue to rely on such 20th-century industries as coal, agriculture, and minerals." For example, West Virginia and Mississippi find themselves at the bottom of both indices. But low-ranking states sometimes outpace others in job creation, Andes says. He points to Wyoming, which ranked 46th on the ITIF index but had one of the largest rates of job creation in 2009 and 2010 due to higher-than-normal revenues from a global increase in mineral prices. A more sound long-term economic strategy, Andes suggests, is for states to find "the sweet spot between R&D and high-value manufacturing."

Dan Berglund, president and CEO of the Ohio-based State Science and Technology Institute, which advises states on technology-based economic development, says that state governments usually take the lead in technology commercialization. But he points out that a critical component of the process, basic research, is funded primarily by the federal government. One concern, Berglund says, is the increasing number of foreign scientists and engineers who graduate from US universities and return home to developing nations. According to the Battelle–*R&D Magazine* 2011 Global R&D Funding Forecast, some of those nations are driving an expected 3.6% global increase in R&D spending in 2011.

China is expected to increase its R&D expenditures by 9.2% in 2011, while the US, still the top R&D funder, is expected to increase spending by 2.8%, with about one-third of that coming from the FY 2011 federal budget. The impact from the loss of human and financial capital to spur US innovation will be felt at the state level, says Berglund. "The question is, What is the federal government going to do about it?"

Jermey N. A. Matthews

Chu adds muscle to clean-energy pitch

Within a year of receiving $24 million from the Department of Energy's Advanced Research Projects Agency–Energy (ARPA–E), a half dozen of the agency's 121 high-risk research projects have attracted an additional $100 million in private-sector investment. Energy Secretary Steven Chu said the investments indicate that the business community is keenly interested in commercializing the advanced battery, solar, and wind technologies that ARPA–E, DOE's newest and smallest R&D entity, began funding in 2010.

Chu and other speakers used ARPA–E's second annual showcase, held 28 February through 2 March, to rally support for clean-energy policies. "From my experience in California, it is absolutely clear that the green economy is the way to keep America competitive abroad and to provide economic growth and jobs at home," former governor Arnold Schwarzenegger told the 2000 conference attendees. The US could slash its greenhouse gas emissions by half and close three-quarters of its coal power plants, he maintained, if the nation were to adopt California policies that have brought per-capita electricity consumption in the state down to 40% of the US average, and take up California's mandate for

one-third of electricity usage to be provided by renewable sources beginning in 2020. A third California energy policy, higher vehicle fuel-efficiency standards, has already been picked up at the federal level.

Chu emphasized the need for the US to quickly ramp up its clean-energy investments to meet the competition from China and other nations that are moving more nimbly to become suppliers to the rapidly growing world market for renewable and other nonfossil-fuel energy sources. China, he told attendees, is home to 25 of the 60 new nuclear power plants under construction worldwide; has the world's highest-capacity, lowest-energy-loss high-voltage transmission lines; and runs the fastest high-speed trains, which travel at 402 kph. China is expected to produce 18–20% of its electricity from renewable sources by 2020, he added.

Competing approaches

Arun Majumdar, whom Chu recruited from Lawrence Berkeley National Laboratory to head ARPA–E, described one program to develop "electrofuels" capable of vastly improving on the 1% efficiency at which sunlight is converted in today's biofuels. The process uses nonphotosynthetic microbes to digest raw materials such as hydrogen sulfide or hydrogen waste products from oil refining or natural gas production, plus carbon dioxide. The resulting biofuels, unlike ethanol, will hold the same energy content as oil. Researchers funded by ARPA–E at North Carolina State University and MIT already have produced such synthetic oil in the lab, he said, and 13 other teams are working on the process. "It will take 10 to 20 years for [the techniques] to scale, and some of them will drop out. Some of them will be cost-competitive. Eventually the market will pick the winners."

For electric vehicles, ARPA–E's "technology agnostic" goals are to double the energy density of today's lithium-ion electric vehicle batteries while cutting the cost by two-thirds. The program has set up a competition among a half-dozen technology candidates, including all-electron, lithium–oxygen, lithium–sulfur, metal–air, and magnesium-ion cells. "We don't know which one's going to work out in the end," Majumdar said. "Perhaps one or two of them might."

For improving the nation's electrical transmission and distribution grid, ARPA–E awardee Cree Research is researching a lightweight replacement for today's 4500-kg, mostly foreign-manufactured electrical substation transformers. Besides cutting transformer weight by two orders of magnitude, the suitcase-size replacements would be semiconductor-based and would provide smart grid capabilities.

David Kramer ■

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