Benchmarking U.S. States for Economic Development from Nanotechnology

U.S. states are in a race to attract investment and create jobs through nanotechnology commercialization. States' level of nanotech activity and general technology development strength determine their positions: Massachusetts, California, Colorado, Virginia, New Mexico, New Jersey, Connecticut, Maryland, Illinois, and New York form the top ten today. Leading states involve all relevant stakeholders in nanotechnology initiatives, focus on commercialization, and play to their strengths.

The Nanotech Economic Development Race Is On

State and local governments poured more than $400 million this year into nanotechnology research, facilities, and business incubation programs, aiming to attract further funds from the nearly $1 billion being disbursed at the federal level. Why the activity? Multiple stakeholders want to see nanotech spark economic development:

- **State and local governments want to create jobs.** State and local governments see parallels between nanotechnology and previous technology waves like biotech, which Ernst & Young estimates created more than 400,000 jobs from 1979 to 1999. With visions of the next Silicon Valley in their eyes, they are willing to gamble on what they see as high-risk nanotechnology initiatives in exchange for a shot at long-term growth. Consider New York State, which has put nearly $400 million into the Albany NanoTech nanoelectronics initiative. This investment has attracted industrial sponsors and partners including GE, IBM, Infineon Technologies, International Sematech, and Tokyo Electron, which have collectively committed more than $1 billion in additional funding since 2002. The initiative has already produced new world-class facilities, state-of-the-art semiconductor fabs, the first college devoted specifically to nanotechnology, and jobs for hundreds of top researchers and support personnel.

Core Topics

- Economic Development and International Competitiveness
- Public Sector Funding

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- **Federal politicians want to get reelected.** Politicians, who live and die at the polls by unemployment figures, feel the same pressure as their state and local peers – only more intensely. They favor nanotech over other cutting-edge technologies because its broad scope has an impact on many parts of their states' economies and because it remains at an early stage of development, giving nearly any state a viable opportunity to compete. After Senator Ron Wyden of Oregon spearheaded the 21st Century Nanotechnology Research and Development Act in Congress – which signed nearly $1 billion in annual federal nanotech spending into law – he supported the creation of the Oregon Nanoscience and Microtechnologies Institute (ONAMI) initiative in his home state. ONAMI has accessed more than $7 million in federal funding this year through Wyden's efforts. These funds have added new equipment and supporting resources at Oregon State University, Portland State University, and the University of Oregon.

- **Corporations want access to fundamental research.** Corporations encourage state nanotechnology development efforts that help them collaborate with leading laboratories and scientists, license intellectual property, and ensure a steady flow of skilled workers. In some cases, they fund these efforts directly, as IBM did by ponying up over $100 million for New York State's Albany NanoTech initiative. In other cases, they collaborate indirectly, as Cephalon, Elan, GlaxoSmithKline, and Itochu do with Pennsylvania's Nanotechnology Institute – a nanobiotechnology-focused collaboration led by Ben Franklin Technology Partners, Drexel University, and the University of Pennsylvania.

- **Start-ups want a nurturing environment.** Start-up companies look to economic development programs to provide location assistance and low regulatory thresholds, as well as access to capital, employees, and seasoned mentors. NanoInk, a spin-out of Dr. Chad Mirkin's lab at Northwestern University, benefited from collaboration between multiple Illinois public sector institutions to develop a frictionless environment for nanotechnology start-ups. NanoInk received help in finding a headquarters location, assistance with raising private financing, and a $1 million Tax Increment Financing grant in exchange for remaining headquartered in the state.

- **Investors want a steady stream of commercializable technologies.** Investors love economic development programs because they help take start-up companies through the "valley of death" from raw idea to commercializable product. The help comes in the form of bridge funding, mentoring, access to shared facilities, and grant-writing assistance. New York State's Small Business Technology Investment Fund (SBTIF) was created to provide start-up high-tech companies with an alternative source of seed capital, and has made great efforts to assist emerging nanotechnology companies in the state. Quantum dot specialist Evident Technologies drew on $525,000 in SBTIF funding to move from an idea to a venture-ready company.

- **Universities want to attract the best scientists.** Universities look to economic development programs to deliver the funding, facilities, and capital equipment – like Class 100 cleanrooms and atomic force microscopes – that they need to entice best-in-class professors and graduate students versed in nanotechnology. In Indiana, Purdue University developed the state-of-the-art Birck Nanotechnology Center by leveraging $5 million of state funding to attract another $46 million in private and federal dollars. The university now competes nationally for major nanotechnology development projects and has been awarded $15 million over five years as

Fig. 1: Nanotechnology Activity Criteria (All Scored Per Capita)

Criterion	Weight	Measurement	Why It Matters
State nanotech spending	20%	State budget dollars specifically allocated to nanotechnology development in 2004	Clearest indication of a state's willingness and ability to develop nanotech innovations
State nanotech initiatives	10%	The creation within the state of a formal nanotechnology initiative with designations made for level of development and commitment of resources	Indicator of level of planning and foresight brought to nanotechnology development
Public companies active	10%	Number of public corporations active in nanotech headquartered in state, drawn from Lux Research *The Nanotech Report 2004* company listings	Unlike with other recent technology waves, corporations are playing as critical – if not more critical – a role in nanotech discovery and commercialization as start-ups
Private companies active	10%	Number of private companies active in nanotech headquartered in state, drawn from Lux Research *The Nanotech Report 2004* company listings, with adjustments made for those start-ups receiving venture capital investment	Measurement of new business creation attributable to nanotechnology
Start-up investment rounds	10%	Total number of rounds of investment in nanotechnology start-ups headquartered in state from 1998 through 2004	Included to weight states with well-funded start-ups over those with a large number of poorly funded start-ups
Federal/ university nanotech centers	10%	Number of federal and university nanotech centers, including university-developed efforts and NSF-funded centers, as well as other federal government and military research centers with a nanotechnology focus	Magnets for academics, breeding grounds for start-ups, and collaboration centers for corporations
Nanotech patents	10%	Number of patents granted by U.S. Patent and Trademark Office with "nano-" or a derivative in the patent title to entities based in state	Indicator of rate of scientific discovery in nanotechnology
Nanotech patent applications	10%	Number of active patent applications registered at U.S. Patent and Trademark Office with "nano-" or a derivative in the patent title to entities based in state	Indicator of rate of scientific discovery in nanotechnology
Nanotech SBIRs	10%	Number of SBIR grants with a nanotechnology focus awarded in state in 2002 and 2003, including both phase 1 and phase 2 grants	Measure of technology entrepreneurship in nanotechnology distinct from start-up company formation and funding

part of the NASA Institute for Nanotechnology and Computing and another $10.5 million over the same time period from the National Science Foundation (NSF) as part of its Network for Computational Nanotechnology.

Two Factors Determine States' Competitiveness

To assess the competitiveness of U.S. states in developing their economies through nanotechnology commercialization, Lux Research developed an assessment tool based on two axes:

- **Nanotechnology activity.** This axis assesses two forms of nanotechnology activity in the state relative to its population (see Figure 1). First, it assesses the level of effort that the state has undertaken to create an environment for nanotechnology to flourish, as measured by the

Fig. 2: Technology Development Strength Criteria (All Scored Per Capita)

Criterion	Weight	Measurement	Why It Matters
R&D inputs	20%	Milken Institute metric: composite of federal R&D, industry R&D, academic R&D, Small Business Technology Transfer (SBTT) and Small Business Innovation Research (SBIR) awards	Raw materials of technology-based economic development
Technology and science workforce	20%	Milken Institute metric: based on U.S. Department of Labor data on the intensity of computer and information workers, corporate scientists and engineers, and biomedical researchers	Required to convert scientific innovations into commercially viable products and services
Technology concentration	20%	Milken Institute metric: composite of concentration of companies in high-tech Standard Industry Classification codes, net formation of high-tech establishments, and growth in high-tech industries	Technology organizations in co-located "clusters" breed more of themselves
Human capital investment	10%	Milken Institute metric: composite of number of science/technology/engineering B.A., M.A., and Ph.D. degree holders, number of students in science and engineering, state appropriations for higher education, households with computers, and households with Internet access	Indicator of investment to develop technology and science workforce
Risk capital and infrastructure	10%	Milken Institute metric: composite of total venture capital investment, Small Business Investment Companies (SBIC) funding, number of business incubators, patents issued, business starts, and IPO proceeds	Indicator of entrepreneurial capacity and behavior – prime drivers of economic growth
Fast 50 companies	10%	Total number of Deloitte Technology Fast 50 companies per capita from 2000 through 2003	Proxy for ability to foster fast-growing companies
Economic Freedom Index	10%	Adjusted calculation of the Pacific Research Institute's U.S. Economic Freedom Index, which examines regulatory hurdles and levels of taxation by state	Cost of taxation and regulation is a key decision driver for site selection among companies that can locate anywhere they'd like

amount of nanotechnology funding allocated at the state level, the status of state nanotechnology initiatives, and the presence of federal and university nanotech centers. Second, it assesses private sector nanotechnology activity that the state can only influence indirectly, as measured by the number of nanotech patents and patent applications, the number of public and private companies active in nanotechnology, and the number of federal small business innovation research (SBIR) grants for nanotechnology applications awarded in the state.

It's important to note that we scored all of our nanotechnology activity metrics *on a per capita basis,* measuring a state's ability to create jobs and attract investment *relative to its population.* A single nanotechnology center in Vermont, for example, would have a much greater impact on that state than the same center would in Texas, with 35 times as many people. Our assessment is not intended to identify states with the greatest level of nanotechnology activity on an absolute scale, although that detail does exist in our source data.[1]

- **Technology development strength.** This axis measures the state's demonstrated ability to develop its economy by promoting science and technology initiatives in general, irrespective of specific activities in nanotechnology (see Figure 2). Since many assessments of this capability already exist, we used one highly regarded set of metrics as the basis of this axis: the Milken

Institute's metrics on R&D inputs, technology and science workforce, human capital investment, technology concentration, and risk capital and infrastructure. In addition, we used the concentration of Deloitte Technology Fast 50 companies in the state as a proxy for past technology development success and the Pacific Research Institute's U.S. Economic Freedom Index as a measurement of relative regulatory hurdles and taxation levels.

Four Categories of States Emerge

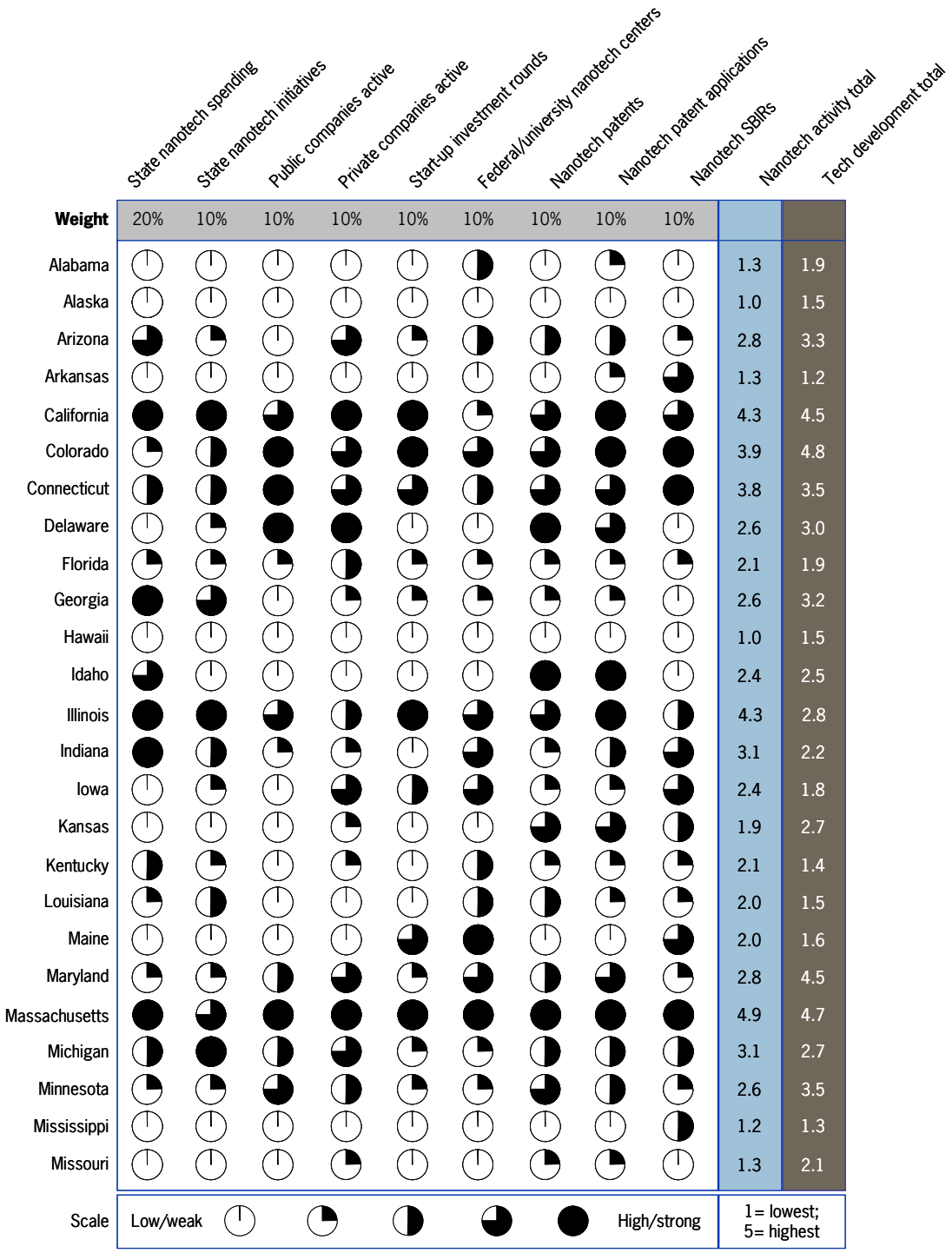
Our analysis ranked each state on 16 quantitative metrics across our two axes, relative to population (see Figures 3a and 3b). The results place states in four categories (see Figure 4):

- **Nano-Leaders.** Nine states combine a high level of nanotechnology activity with a high degree of general technology development strength. They include the usual suspects like California and Massachusetts, as well as surprises like Colorado and New Mexico. These states are best positioned to create jobs and attract inward investment through nanotechnology commercialization; the onus is on them to maintain their positions as the field matures.
- **Nano-Aspirants.** Seven states boast high levels of nanotechnology activity relative to their populations, but don't have a history of the technology development strength needed to convert this activity into economic growth. Oklahoma, for example, has aggressively developed the Oklahoma Nanotechnology Initiative, but is held back in exploiting its activity by scant R&D inputs and a small technology and science workforce.
- **Nano-Laggards.** Nine states excel at using high technology to develop their economies, but have not focused on nanotechnology – instead applying their strength to other fields such as biotech, software, and semiconductors. For example, Georgia boasts fine universities, an abundance of technology and science workers, sufficient risk capital, and a high degree of economic freedom – all magnets for technology commercialization. But its government and business leaders have concentrated on developing centers of competence in information technology – in particular information security – while devoting relatively little attention to nanotech. The state has not developed a detailed plan for attracting nanotech investment, and flagship university Georgia Tech has held back from beginning work on a nanotechnology center due to a $36 million pledge that has yet to materialize after nearly two years.
- **No-Shows.** The remaining 25 states score low both on nanotechnology activity and technology development strength. Focused efforts on both fronts would be required to vault them into the ranks of the Nano-Leaders.

The Top Ten – and the Next Five – Are on the Road to Success

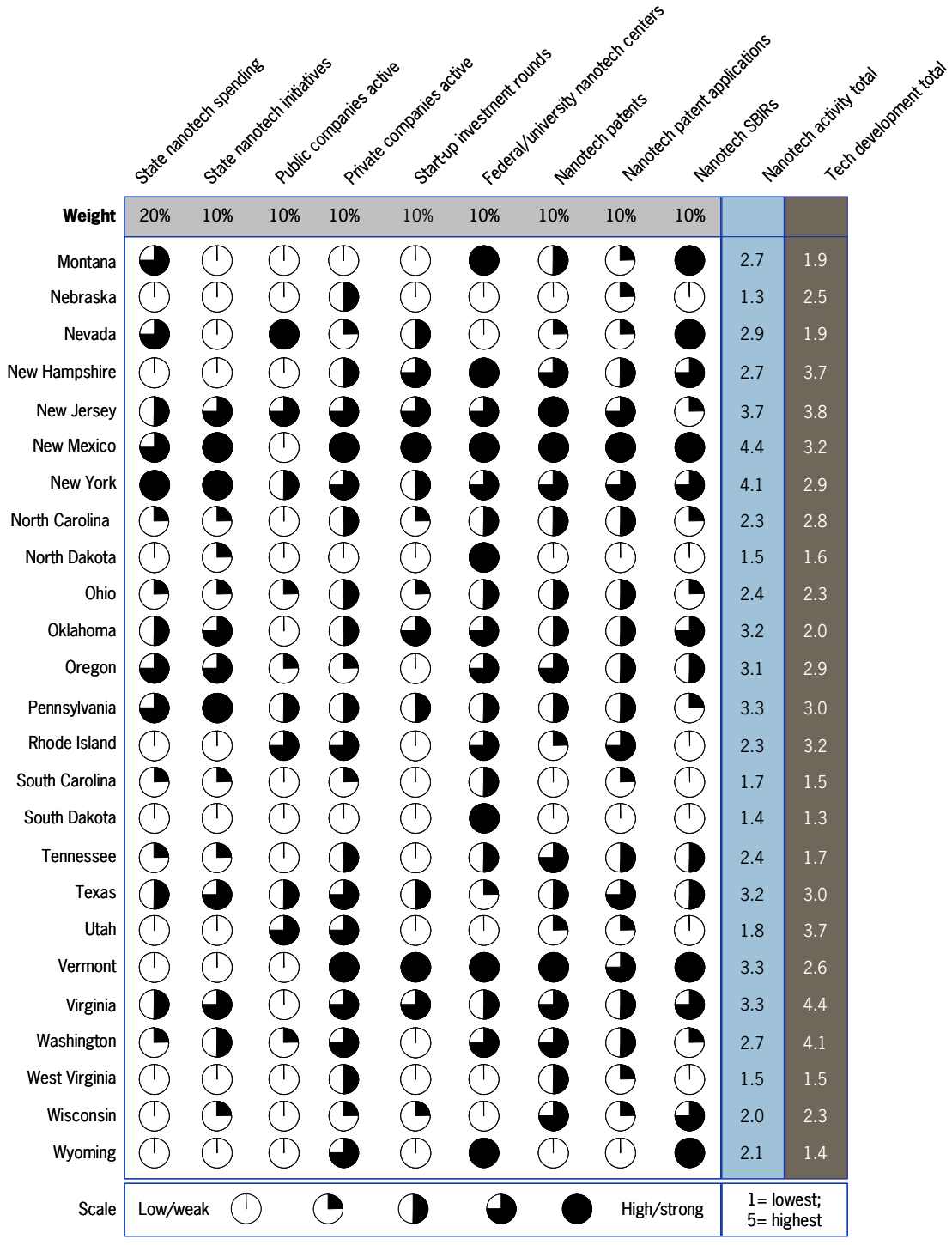
Adding the scores on both axes together produces a linear ranking that represents, on balance, a state's ability to develop its economy through nanotechnology relative to its population (see Figure 5).[2] It's meaningful to combine the two measures because states with great expertise in developing advanced technologies in general will be able to yield more jobs per dollar of nanotech funding; conversely, those with burgeoning nanotech activity may be able to counter weak technology

Fig. 3a: Scoring States for Economic Development from Nanotechnology, First 25 States



All metrics have been scaled per capita except for "state nanotech initiatives," a qualitative metric.

Fig. 3b: Scoring States for Economic Development from Nanotechnology, Last 25 States

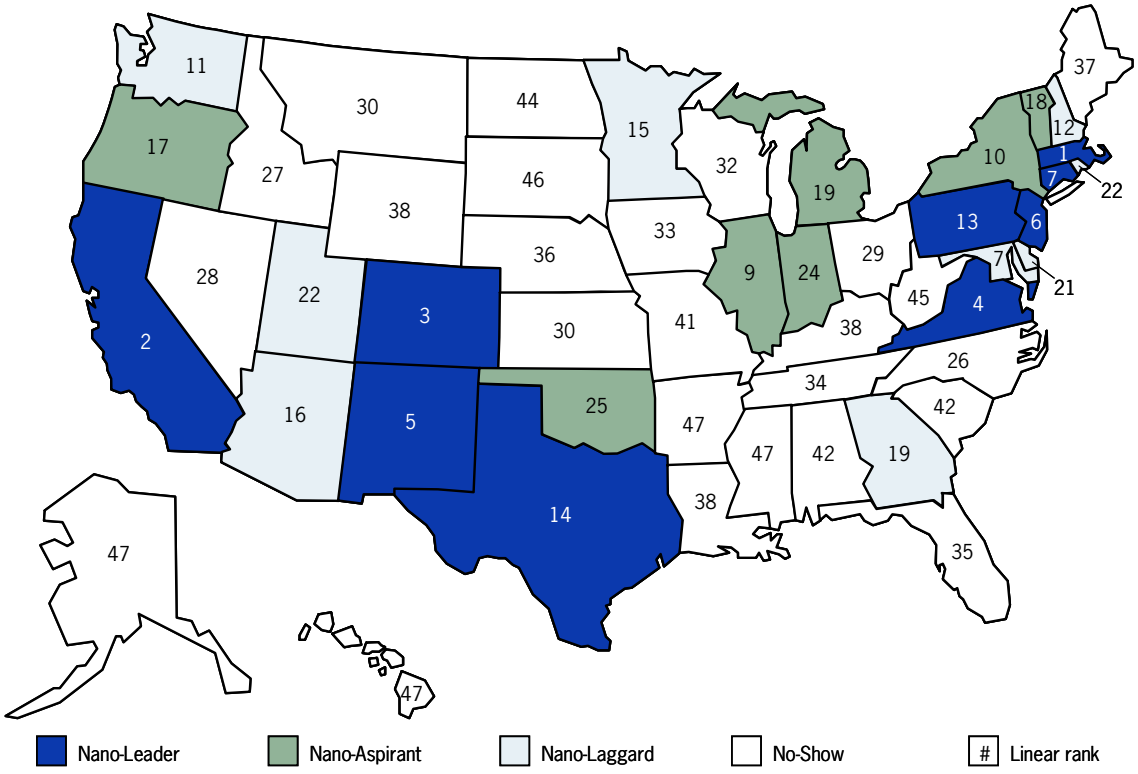


	State nanotech spending	State nanotech initiatives	Public companies active	Private companies active	Start-up investment rounds	Federal/university nanotech centers	Nanotech patents	Nanotech patent applications	Nanotech SBIRs	Nanotech activity total	Tech development total
Weight	20%	10%	10%	10%	10%	10%	10%	10%	10%		
Montana										2.7	1.9
Nebraska										1.3	2.5
Nevada										2.9	1.9
New Hampshire										2.7	3.7
New Jersey										3.7	3.8
New Mexico										4.4	3.2
New York										4.1	2.9
North Carolina										2.3	2.8
North Dakota										1.5	1.6
Ohio										2.4	2.3
Oklahoma										3.2	2.0
Oregon										3.1	2.9
Pennsylvania										3.3	3.0
Rhode Island										2.3	3.2
South Carolina										1.7	1.5
South Dakota										1.4	1.3
Tennessee										2.4	1.7
Texas										3.2	3.0
Utah										1.8	3.7
Vermont										3.3	2.6
Virginia										3.3	4.4
Washington										2.7	4.1
West Virginia										1.5	1.5
Wisconsin										2.0	2.3
Wyoming										2.1	1.4
Scale	Low/weak								High/strong	1= lowest; 5= highest	

All metrics have been scaled per capita except for "state nanotech initiatives," a qualitative metric.

Fig. 4: U.S. States Fall into Four Categories

Fig. 5: Leading States Span the U.S.



development skills through the sheer volume of innovations emerging from their university labs. Out of this linear ranking, we highlight:

- **The top ten.** Leading our linear ranking: Massachusetts, California, Colorado, Virginia, New Mexico, New Jersey, Connecticut, Maryland, Illinois, and New York (see Figures 6a and 6b). In all of these states, multiple anchors – including universities, government labs, corporations, and start-ups – drive and commercialize nanotechnology discoveries, instead of a single university, start-up cluster, or Fortune 500 company. All also boast highly educated populations and levels of entrepreneurship that sustain multidisciplinary, cutting-edge fields like nanotechnology. Their biggest differences emerge in such areas as regulation and taxation, which can swing site-selection decisions for start-ups and corporations: Colorado and Virginia stand among the very best while California and Connecticut represent the very worst.
- **The next five.** The next five states deserve scrutiny due to their rising momentum and unique nanotech activities (see Figure 6c). Washington State has struggled to operationalize a statewide nanotech initiative, but created one of the first nanotechnology degree programs at the University of Washington. Though New Hampshire state officials have done little to promote nanotechnology, the University of New Hampshire has aggressively sought to develop nanotech and partnered with Massachusetts' Northeastern University as part of the NSF Center for High

Fig. 6a: Strengths and Vulnerabilities in Top U.S. States: One through Five

State	Rank	Strengths	Vulnerabilities
Massachusetts	1	• Leading research institutions with federally backed centers at Harvard, MIT, and Northeastern; additional nanotech efforts at Boston University and University of Massachusetts Amherst • High volume of investment capital: Battery Ventures, Bessemer Venture Partners, Charles River Ventures, Polaris Venture Partners, and Venrock Associates have nanotech investments • Experienced pool of managers and workers • Track record in commercializing science • Concentration of tech companies along Route 128 corridor	• State has failed to focus on nanotech or develop a focused strategy to exploit research assets • High taxes and regulatory hurdles present difficulties for start-ups, causing many to leave the state • Lack of intrastate cooperation between research programs
California	2	• Leading research institutions include California Institute of Technology, Stanford, University of California Berkeley, and California NanoSystems Institute • Federal programs: Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, and NASA Ames Research Center • Leads nation in tech-focused investment capital • Experienced pool of managers and workers • 53 Fortune 500 companies in the state, with more than half likely to benefit directly from nanotech's growth • More than 120 private companies active, including leading start-ups like Nanomix, Nanosys, and Nano-Tex	• Second-worst state for high taxes and regulatory hurdles • Lack of intrastate cooperation, with redundant activity among multiple Silicon Valley institutions • Presumption of leadership risks underinvestment in the future • California NanoSystems Institute has undergone multiple leadership shake-ups
Colorado	3	• Many promising start-ups, including ITN Energy Systems, NanoProducts, and ZettaCore • High volume of investment capital • Second-highest economic freedom rank, owing to low taxes and regulatory hurdles • Leadership from Denver, Adams County, Jefferson County, National Institute of Standards and Technology, National Renewable Energy Laboratory, Colorado School of Mines, Colorado State University, University of Colorado, University of Denver • Experienced pool of managers and workers and significant state investment in education and development • Among nation's highest concentrations of tech companies	• State government remains unfocused on nanotech • No statewide nanotech plan • State university system has yet to organize nanotech assets into a formal network • State spends little on nanotech funding, relying mostly on federally backed efforts
Virginia	4	• More than 30 federal government labs and research institutions; home of Defense Advanced Research Projects Agency and NSF • Leading research institutions in University of Virginia and Virginia Tech • Strong presence of major government contractors involved in nanotech, including General Dynamics and SAIC • Experienced pool of managers and workers from late 1990s tech boom and government lab structure	• Though governor is a tech entrepreneur, has focused on fiscal restraint, not economic investment • Research institutions in center and south; commercialization infrastructure in north • Has yet to develop or be awarded any major nanotech institutes
New Mexico	5	• Announced first formal state nanotech initiative in 2001 • Recently broke ground on the 96,000-square-foot core facility of the Sandia/Los Alamos joint Center for Integrative Nanotechnology • Great project planning, focus, and coordination between University of New Mexico and federal labs on nanotech • Strong nanotech leadership from Governor Richardson and Senators Bingaman and Domenici • Aggressive outreach efforts by state government and regional bodies like Albuquerque	• Historic failure to retain start-ups • Lack of start-up infrastructure such as investors and services firms • No Fortune 500 companies headquartered • Thin concentration of tech companies • Among lowest-rated states in the region in economic freedom

Fig. 6b: Strengths and Vulnerabilities in Top U.S. States: Six through Ten

State	Rank	Strengths	Vulnerabilities
New Jersey	6	• Leading research institutions, including Bell Labs, New Jersey Institute of Technology, Princeton, Rutgers, and Stevens Institute of Technology • Many Fortune 500 companies, including Engelhard, Honeywell, Johnson & Johnson, Lucent, Merck, and Wyeth • High level of technology firm concentration in pharma/biotech, electronics, and materials • Experienced pool of technology managers and workers	• Difficulties launching and coordinating efforts, with shake-ups at the New Jersey Nanotechnology Consortium • High taxes and many regulatory hurdles • State has yet to plan and organize a formal effort; several competing private efforts have launched instead
Connecticut	7 (tie)	• Fifteen Fortune 500 companies headquartered with many active in nanotech, including GE, Pitney Bowes, Praxair, United Technologies, and Xerox • Focus by state officials, including Senator Lieberman and Governors Rowland and Rell • Leading research institutions, including University of Connecticut and Yale • Among top producers of Fast 50 companies	• Historic failure to retain start-ups, due to taxes and regulatory hurdles • Overreliance on federal and corporate funding for nanotech, spending little of its own budget • State has yet to establish a leading nanotech center • Possesses a high volume of risk capital, but little flows into start-ups headquartered in state
Maryland	7 (tie)	• Leading federal research institutions, including Army Research Laboratory, Beltsville Agricultural Research Center, NASA Goddard Space Flight Center, National Cancer Institute, National Institutes of Health, and two dozen others • Johns Hopkins University and University of Maryland have solid nanotech programs • One of the leading science and tech workforces • Large defense industry players focusing on nanotech active in state like Lockheed Martin, Northrop Grumman, and Raytheon	• Until recent traction in biotech, state had historically failed to retain start-ups • State spends very little on nanotechnology, relying on federal government and corporations • Lacks extensive entrepreneurial infrastructure of investors, skilled start-up execs, and tech-focused service firms
Illinois	9	• State government leadership from governor, state agencies, and mayors results in high research spending, tax breaks, and other support programs • Leading research institutions: Argonne National Laboratory, Northwestern, University of Chicago, and University of Illinois • Leading venture-backed start-ups like Arryx, NanoInk, and Nanosphere • Many leading companies researching and commercializing nanotech, including Abbott, Baxter, Boeing, Caterpillar, Kraft, Motorola, and Nanophase • Solid support from associations such as AtomWorks and Chicago Microtechnology & Nanotechnology Community	• State lacks risk capital to support start-ups • Historic failure to retain start-ups • High taxes and many regulatory hurdles dampen appeal of average-size tech workforce • Lacks concentration of science and tech companies held by many other leaders
New York	10	• Governor Pataki has committed the state to spend more on nanotechnology than any other state • Three of the original six NSF nanotech centers (Columbia, Cornell, Rensselaer Polytechnic Institute) • Additional leading research at Brookhaven National Laboratory, New York University, Rochester Institute of Technology, State University of New York, and University of Albany (Sematech) • Wall Street yields high volume of investment capital • Incentive programs and grants relevant to nanotech start-ups, including the SBTIF program • Many leading corporations, including Bristol-Myers Squibb, Corning, GE Labs, Kodak, and Pfizer	• Lack of statewide nanotech plan and coordination between universities, companies, and government labs makes efforts inefficient • Highest combination of taxes and regulatory hurdles in the country • State fails to retain start-ups; several, including C Sixty, have already left due to business climate • Competing New Jersey has equivalent access to New York City risk capital and start-up infrastructure

Fig. 6c: Strengths and Vulnerabilities in Top U.S. States: 11 through 15

State	Rank	Strengths	Vulnerabilities
Washington	11	• University of Washington was first university worldwide to develop a nanotech degree program and among the first to develop a nanotech center • Institute for Systems Biology, Pacific Northwest National Laboratory, and Washington State University also conduct significant nanotech research • Highly educated and entrepreneurial workforce	• State focused on biotech and has not developed a nanotech strategy or significantly funded nanotech efforts • Has several leading nanotech start-ups, including CombiMatrix, Lumera, and Neah, but has few corporations developing nanotech at this time • Recent loss of leadership for state nanotech research efforts with the departure of Dr. Viola Vogel to Switzerland
New Hampshire	12	• Leading research at Dartmouth and University of New Hampshire (including participation in NSF-funded Center for High Rate Nanomanufacturing) • Proximity to Massachusetts nanotech research has allowed for a high concentration of tech companies • Lowest taxes and regulatory hurdles in the Northeast	• State leaders have not focused on nanotech and have a laissez-faire track record on economic development: no planning and little funding • Few corporations active in nanotechnology • Small science and technology workforce
Pennsylvania	13	• Leading research institutions include Carnegie Mellon, Drexel University, Pennsylvania State University (NSF center), Temple University, University of Pennsylvania, University of Pittsburgh • State-backed Ben Franklin Institute has developed $600 million in federal funding for state researchers • Governor Rendell is a strong supporter and recently announced increased nanotech funding • Leading corporations in state strongly backing nanotech, including Air Products and Chemicals, Elan, GlaxoSmithKline, Itochu, Merck, PPG, and Rohm and Haas • Highly focused on workforce development efforts	• Historically strong at research and weak at commercialization • Start-ups leave for regions with better start-up infrastructure and funding opportunities • Low economic freedom • Regional focus (DE, MD, DE, NJ, PA) of planning on nanotech difficult to implement and control
Texas	14	• Rice University (NSF center) and University of Texas system among the strongest in nanotech • Congressional delegation strongly supports nanotech, bringing back over $50 million in federal earmarks and funding • Low taxes and regulatory hurdles • Leading start-ups, including Carbon Nanotechnologies Inc., Molecular Imprints, and Nanospectra Biosciences • Evangelizing force of Nobel Laureate Richard Smalley	• Laissez-faire state government leadership on economic development • Lack of start-up infrastructure and risk capital outside of Austin • Small (but growing) science and technology workforce • No statewide plan yields unproductive competition arising between regions within the state • Few corporations focused on nanotech • Austin-based Sematech's next-generation semiconductor research being conducted in New York
Minnesota	15	• Leading companies backing nanotech, including 3M, Cargill Dow, Entegris, Medtronic, and NVE • University of Minnesota is a leading institution in nanotech research • One of the leading states in human capital investment	• Still in planning stage for its OMNI nanotech initiative • Few nanotech start-ups • No history of developing leading start-ups • State spends little on nanotech

Rate Nanomanufacturing. Pennsylvania has dedicated itself seriously to nanotechnology very recently and is working to build regional alliances with corporations and universities in the mid-Atlantic through Ben Franklin Partners. Texas has a thriving cluster of start-up companies spurred by leading research at Rice University and the evangelizing presence of Nobel Prize winner Richard Smalley, but lacks additional centers for nanotechnology in a state with a huge population. And while Minnesota is still in the planning stage for its Organization of Minnesota Nanotechnology Initiatives (OMNI), it nonetheless boasts stellar R&D both at the University of Minnesota and at locally active corporations like 3M and Cargill Dow.

Best Practices from the Nano-Leaders

States at the top of our rankings:

- **Involve all relevant stakeholders in developing nanotechnology initiatives.** Government funding isn't going to nanotech because politicians have fallen in love with science: It's because they want to spur job creation, period. Too many states allow scientific progress to eclipse commercial development and leave commercialization planning to university officials – or even worse, to scientific researchers themselves – while buy-in from business leaders and investors is taken for granted

  It is of the utmost importance for nanotechnology economic development that all key stakeholders have a hand in building the initiative – university officials, researchers, investors, government leaders, entrepreneurs, corporate executives, service industry representatives, and other supporting organizations. Illinois state governments led by Governors Blagojevich and Ryan – in partnership with the Daly Administration in Chicago – have driven nanotechnology development aggressively via state research funding, tax incentives, and location assistance for start-ups. Further, they have actively marketed the state as a hub through the annual NanoCommerce event. Key to their success has been the inclusion of all relevant stakeholders: corporations (such as Boeing, Caterpillar, Kraft, and Motorola), universities (Northwestern, the University of Chicago, and the University of Illinois), nanotech start-ups (including Arryx, NanoInk, and Nanosphere), federal government labs (Argonne National Laboratory and Fermilab), investors (including nLake Technology Partners and Portage Venture Partners), and supporting associations (AtomWorks and the Chicago Microtechnology & Nanotechnology Community).

- **Focus on commercialization from the outset.** States' biggest levers in developing commercializable nanotech opportunities tend to be their public university systems, where they can shift funding between programs or introduce new ones unhindered. But in many states, government leaders let universities structure nanotechnology initiatives without input from stakeholders with a commercial interest. They end up with stellar research facilities, but commercialization efforts left to understaffed and underskilled technology transfer departments.

  It is vital that states remember that university research is the beginning, not the endpoint, of commercialization efforts: It is entrepreneurs and corporations that bring the economic impact to fruition. California's efforts, best represented by the California NanoSystems Institute, form a

fine example of creating an environment to commercialize and develop academic research. This $400 million project – a collaboration between the University of California at Los Angeles and the University of California at Santa Barbara – hired Derrick Boston, an experienced entrepreneur and investment banker, to lead the commercialization effort. He in turn involved corporations (including Accelrys, Agilent, Hewlett-Packard, Intel, Rockwell Automation, Sun Microsystems, and Veeco Instruments) and investors (including Apax Partners, ARCH Venture Partners, Bear Stearns, Draper Fisher Jurvetson, and JPMorgan Partners) from the get-go, ensuring a focus on commercialization.

- **Play to strengths.** In the long term, nanotechnology will affect nearly every sector of the economy. No region has enough time, money, or people to pursue every area of impact, and most will be poorly served by going after the same fields in which other states have already established leadership positions. Clearly, differentiation is required.

  States that are winning the nanotech race realize this and focus on applying nanoscale innovations in fields where they either already excel or have an opportunity to stake out new territory. Arizona stands as a good example of a state that took stock of its assets and built nanotech initiatives around them. After a donation from Motorola presented equipment and facilities well suited to specific applications like biosensors, display technology, and energy solutions for portable electronics devices, Arizona State University (ASU) moved quickly to task its research and technology transfer staff toward these specific fields – even hiring ex-Motorola researchers to build them out. This focus was rewarded when the state assembled a consortium that won a $43.7 million grant to establish the Army Flexible Display Center at ASU.

Methodology

Lux Research conducted extensive secondary research to populate our assessment tool in Q4 2004. Our sources included public documents, patent and SBIR database searches, an exhaustive review of economic development literature, and trade and business press articles. In addition, we drew on our ongoing interactions with public sector officials, trade association leaders, corporate executives, and start-up company CEOs involved in state-level nanotechnology economic development efforts.

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1 We plan to publish an additional brief in Q1 2005 that will rank states on an absolute basis, which is the perspective most important to corporations looking to select sites for nanotechnology efforts.

2 Again, note that this does not imply that states higher than others in the ranking boast more funding for nanotechnology or a greater number of relevant Ph.D. scientists on an absolute basis.