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VIRGINIA'S REGIONAL ENERGY INNOVATION CENTERS INITIATIVE: LESSONS LEARNED FROM INNOVATION CENTERS ACROSS THE U.S.

EXECUTIVE SUMMARY

Expectations are high for regions to increase innovation capacity and strengthen research and development to compete in a global economy. The "new economy" favors locations with abundant knowledge resources rather than the industrial resources of old. Driving innovation-led economic expansion has been investment in knowledge resources, particularly R&D.

In 2008, Virginia sought to address the economic distress in southern/southwest Virginia by creating Regional Energy Innovation Centers. The largely rural region had seen a decline in the economic impact of tobacco production and significant employment losses from the decline and off-shoring of manufacturing jobs—in textiles and manufactured wood products.

We benchmarked the significant investments other states have made in signature research centers and centers of excellence to stimulate innovation-led economic development. Typically, these centers are seeded through state funding and based on a public-private partnership. This paper summarizes key attributes of successful innovation centers and discusses recommendations developed for Virginia.

VIRGINIA'S REGIONAL ENERGY INNOVATION CENTERS INITIATIVE

The Regional Energy Innovation Center Initiative in Virginia is positioned to stimulate economic growth in stressed regions of the Commonwealth, strengthen regional industry, and align with the goals outlined in the 2007 Virginia Energy Plan. Three organizations will create new energy R&D centers that will constitute the Initiative: the Southwest Virginia Higher Education Center, the Center for Advanced Engineering and Research, and the Institute for Advanced Learning and Research Foundation.

- The Clean Energy Field-based R&D Center will be located in Abingdon and dedicated to increasing the productivity, competitiveness, and job base of Southwest Virginia's coal and natural gas industries.
- The Nuclear Energy R&D Center (Center for Advanced Engineering and Research) will promote growth in Region 2000's[1] existing nuclear cluster by providing R&D, education, and training instrumental in addressing the challenges faced by the re-emerging nuclear power industry.
- Sustainable Energy Technology Center (SEnTeC), located in Danville, will work to reinvigorate the agriculture-based economy of Southside Virginia by testing and commercializing advancements in biomass production and conversion technologies.

This initiative is aligned with the Virginia Energy Plan's goal to "capitalize on economic development opportunities through business expansion and increased R&D in areas of strength, including **alternate transportation fuels**, **nuclear technology** … and **carbon capture and storage.**" Each center is targeted to facilitate public-private partnerships and provide the knowledge resources that will fuel expansion of industry clusters within their regions. More generally, these centers are also highly consistent with

[1] Region 2000 refers to the 2,000 square mile area incorporating Amherst, Bedford, Appomattox, and Campbell Counties; the Cities of Lynchburg and Bedford; and the Town of Altavista, all in Virginia.

recent national trends toward public support of energy research, particularly research on clean and renewable energy, as a tool for regional and statewide economic growth.

In the course of the planning for these centers, we examined recent literature on innovation-led economic development efforts in other states, including R&D funding and investments in innovation centers. The lessons learned were used to develop the mission, goals, and structure of each center as well as to communicate to state leaders, funders, and regional industry their potential roles in supporting—and benefiting from—the Initiative.

BEST PRACTICES AND BENCHMARKING

A recent policy paper from the Pew Center for the States and the National Governors Association (NGA) provided a thorough analysis of trends and best practices in states' investment in innovation.[2] With relatively smaller investments in R&D, states can influence the future dramatically by investing in R&D that serves specific economic and social needs within their borders. The report concludes, "R&D efforts must be considered investments, not expenditures." States and regions must begin by carving out areas where returns are tangible, not only in building talent and in high-paying jobs, but in solutions to pressing social problems, improved business productivity, and success in global markets.

The Pew Center and NGA report identified six best practices for state R&D investments.[3]

1. **Develop a statewide research and innovation strategy that aligns components in ways that provide advantages to in-state companies.** Innovation economy components include universities, research laboratories, industry leadership, effective communication and collaboration networks, superior infrastructure, talented workforce and good quality of life, and investment funding and entrepreneurial culture.

2. **Make investments to gain talent, build top-notch research enterprises, and compete for federal funding.** Build on existing intellectual strengths, making certain there is a business cluster to take advantage of benefits of new knowledge. As noted by Mike Cassidy, president of the Georgia Research Alliance, "Business leaders provide invaluable insight and judgment … and the political support and continuity of vision that are important to sustaining the program over time."

3. **Encourage collaboration among research organizations and the private sectors.** Position the state in the Open Innovation era by steering investments to industry-university collaborations, building cross-disciplinary centers, and facilitating cooperation across multiple universities.

4. **Put world-class professionals in key positions.** Enlist business know-how to provide insight and judgment on appropriate fields of research and to focus on commercialization, as well as to ensure political support and continuity of vision. Increasing innovation capacity requires targeted and sustained investment to build research expertise and provide effective management of R&D and business operations.

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[2] The Pew Center on the States and the National Governors Association, "Investing in Innovation," 2007. http://www.nga.org/Files/pdf/0707INNOVATIONINVEST.PDF . Accessed March 2009.
[3] *Ibid.*

5. **Create an organization and consistent funding source that facilitates continuity in R&D partnering and spending.** Wise states avoid a flip-flop approach—they institutionalize the idea of long-term investment so that it can survive economic downturns and changing administrations. This is easiest when the R&D is focused on an issue of keen interest to taxpayers (such as energy in the case of the proposed regional energy innovation centers in Virginia).

6. **Hold recipients of public investments accountable for delivering promised benefits.** Experience from state programs suggests that immediate job creation is unlikely, and even successful research may take 10 years to bear economic fruit. Yet, successful programs measure a number of intermediate outcomes to provide ongoing accountability, shifting later to more tangible economic outcomes of jobs, wage growth, new industries, and innovation outputs.

Benchmark Centers

To better understand the key lessons to establish a solid foundation for the Regional Energy Innovation Center Initiative, RTI International (RTI) gathered data from a number of comparable initiatives. These are briefly summarized below, followed by lessons learned.

Oregon Nanoscience and Microtechnologies Institute

The Oregon Nanoscience and Microtechnologies Institute (ONAMI, http://www.onami.us/) is an economic development initiative that integrates the nanoscience and microtechnology programs at Oregon's major science and technology research institutions (Oregon State University, Portland State University, University of Oregon, Pacific Northwest National Laboratories, and more recently, Oregon Health and Science University). The state of Oregon provided initial funding of approximately $20 million for capital construction at three locations and $1 million in operating funds. The state provides ongoing support of $9 million per biennium, allocated as follows:

- $2M for proposal matching (typically matched by industry and/or university)
- $3M for faculty start-up packages and equipment (matched 1:1 by university)
- $2.5M for a proof of concept/gap fund for commercialization
- $1.5M for facilities operations/staffing

Oregon businesses have contributed an additional $29.7 million, calling ONAMI's workforce development, economic diversification, and commercialization strategies paramount to the state's economic vitality.

A recent economic impact analysis completed by RTI found that the unique collaborative structure—leveraging each university's strengths rather than competing for limited resources—makes Oregon's research universities and their private-sector partners more competitive for public-private R&D centers, research grants, and other sought-after opportunities. Between FY 2004 and FY 2008, ONAMI researchers

- submitted proposals worth more than $562 million (an annual growth rate of 57%);
- received project and grant awards worth $110 million (an annual growth rate of 65%); and
- accounted for $198 million in research activity (an annual growth rate of 78%).

The economic impact analysis calculated economic benefits of the state's investment (net of the state's total contribution of $38 million) of $69 million, which corresponds to a benefit-to-cost ratio of 2.15 and an internal rate of return of 76%. Estimates of indirect job creation impacts show that ONAMI programs may yield between 1,360 and 2,100 new jobs by 2013 (in addition to the jobs in Oregon's communities that are supported by ONAMI's ability to secure research funding).

Indiana Center for Coal Technology Research

The Indiana Center for Coal Technology Research (CCTR, http://www.purdue.edu/dp/energy/CCTR) was established in 2005 with a primary focus on applied and industry-sponsored research to identify suitable coal technologies to meet the economic and environmental priorities of Indiana. Near-term goals include developing an understanding of the current decision processes of purchasers of Indiana coals, primarily the electric utilities. Longer-term research objectives include assessing the technology factors that will control future coal use in Indiana, the Illinois Basin, and the Midwest region.

CCTR received $1 million in operating seed capital from the state, of which 50% was used for salaries and outreach efforts for three years and 50% for cost sharing to obtain grants. Because seed funding supported the staff to identify and broker federal grants and industry-driven projects, the center already supports about 14 active applied research projects each year. Ongoing state support for cost sharing and overhead operations is provided by an energy fund created through proceeds from a utility company buyout. The energy fund will contribute $500,000 to CCTR each year, for five years. Approximately 20 positions are supported with state and federal grant funds.

Coal Research Center

The primary mission of the Coal Research Center (CRC, http://www.crc.siu.edu) at Southern Illinois University is to identify and initiate new research areas, opportunities, and programs that facilitate the development of improved coal extraction and utilization methods. Areas of research include gasification technologies, combustion technologies, pre-combustion coal technologies, by-products management, mining and power production systems, and power plant expansion issues.

Drawing from a pool of approximately 30 faculty at multiple locations, the CRC typically supports 15 research projects, with an average expenditure of $3 million, in any given year. The center receives ongoing state support for five positions that manage the center's operations, broker research projects across various disciplines, seek federal funds, and coordinate industry projects. Equipment in shared lab facilities is paid for through grants and other contributions, including state funding. Illinois provides significant research funds through the Office of Coal Development of the Illinois Department of Commerce and Economic Opportunity. These state grants—ranging from $50,000 to $1.5 million—provide additional funding for projects and operating costs of coal research programs.

Michigan Biotech Institute

MBI International (also known as the Michigan Biotech Institute, http://www.mbi.org) was officially chartered in 1981 by a State of Michigan economic development task force. Since then, MBI has built a successful track record of innovation in industrial biotechnology—commercializing various products and processes through joint ventures and start-up companies.

MBI is housed in a $10 million, 120,000 sq. ft. facility funded by a state loan. Start-up operations (approximately $500,000, including 4 staff positions) were also funded by the state. MBI has since grown to 5 administrative/executive staff, 23 researchers, and 7 facilities people. The current annual budget is around $4 million per year with 25% of revenues from federal sources, 25% from contract

work, 12% from industry, and 38% from private foundations. MBI has not received state funding for more than 10 years. MBI has had a number of success stories, including but not limited to the following.

- As part of a joint venture with Cargill, Inc., MBI conducted the engineering, scale-up and applications research for the production of PLA biodegradable plastics technology.
- An innovative process to produce 3-hydroxybutyrolactone, a critical intermediate for the cholesterol-lowering statin drug Crestor was licensed from Michigan State University for development at MBI. The start-up that licensed the technology was eventually acquired by Avecia.
- A joint venture between an MBI subsidiary and a Japanese industrial products company developed a family of polymer resins that are processed into films and moldable products for disposable use applications. These polymers are used in disposable cutlery, plastic containers, and paper coatings.

NextEnergy

NextEnergy (http://www.nextenergy.org) was founded in 2002 and capitalized with a $30 million seed grant—used for facility construction and start-up operations—from the Michigan Economic Development Corporation. NextEnergy's mission is "to enable the commercialization of energy technologies that positively contribute to economic competitiveness, energy security, and the environment." Projects and products providing impact today include mobile power (without flickers and surges), biodiesel, next-generation hybrid vehicles, and wind power component manufacturing.

NextEnergy dedicated a 45,000-sq.-ft. facility near Detroit's Wayne State University in the summer of 2005. The center presently has 18 administrative and executive (i.e., nonresearch) staff and approximately 25 researchers and graduate students—almost tripling its staff in the past 18 months.

NextEnergy started to see tangible economic results (and a significant number of them) in mid-2007 and forward. Critical success factors for NextEnergy include focused leadership on a singular goal and a leadership team that remains flexible enough to leverage opportunities as they arise and marshal significant organizational resources around these opportunities to positively influence Michigan's economy.

Bioeconomy Institute

Iowa State University's Bioeconomy Institute (BEI, http://www.biorenew.iastate.edu) is an outgrowth of the 2002 Bioeconomy Initiative. It focuses on biorenewables, turning plant-based materials into bio-based products, including biofuels and bioenergy. The start-up budget was $150,000 per year, funded by the university. Their current annual operating budget is now $1 million per year (exclusive of research expenditures). The current amount of sponsored research funding is approximately $17 million. Their research awards have varied from year to year, but from 2002 to 2006, it totaled approximately $43 million. The breakdown of sources for the 2006 research funding was 81% federal, 9% state, and 10% other, including industry.

BEI was located in an office on the ISU campus for their first six years, and in 2008 the State of Iowa issued a grant of $32 million to build a dedicated facility for the institute. BEI currently has six full-time equivalents, including an administrative specialist, an educational program coordinator, an industrial liaison, two associate directors (for research and education), and a director. BEI does not

directly staff research faculty, but has 160 affiliated research faculty through the university (similar to ONAMI). The new center is positioned to play a prominent role in Michigan's growth and economic development – it is expected to create 100 direct jobs, most of which will require scientific and technical backgrounds.

Lessons Learned

Experience across the United States has shown that Innovation Centers are smart economic investments as they provide:

- A "grow your own" economic strategy, building on existing state and regional strengths
- A means to keep existing industries competitive on a global scale
- A targeted way to seize emerging economic opportunities with high-growth potential
- Strong direct and indirect economic impact

In preparing business plans for this Initiative, RTI evaluated national best practices and benchmark centers, yielding these key findings to guide investment in this Initiative. Review of research articles and policy papers provides the following insight on best practices:

- States are directing increasing dollar amounts to R&D investments, fueling industry-university-government partnerships with goals to address both social needs (such as energy and health) and economic transformation**. Typical investments range from tens to hundreds of millions of dollars**.

- These investments help states and regions compete in the innovation economy by gaining talent, building top-notch research enterprises to compete for federal funding, and creating new innovation-based companies. State funds typically **leverage federal and industry funding at a ratio of about 1:3**.

- Effective innovation centers are **highly collaborative in building partnerships** across universities and between research labs and industry partners—ensuring that research is driving innovation that is economically relevant.

- **Continuity of vision and financial support is essential** to R&D partnering and ensures that such R&D investments are sufficiently sustainable to begin to deliver on promised benefits.

- As they mature, innovation centers are accountable for a set of metrics along a continuum—research metrics, innovation metrics, and economic growth metrics. **States must treat R&D as an investment** whose return on investment may take 10 years or more to bear full fruit.

The State's Role

Findings from the NGA, the Council on Competitiveness, and others clearly illustrate the increasing economic competition America faces from an array of other nations. The report, *Where America Stands*, notes, "Competing successfully in global markets will demand even more speed, flexibility,

specialization and innovation. All firms—large and small—must identify ways to become more innovative and entrepreneurial."[4]

According to the McKinsey Global Institute's study, *U.S. Productivity Growth: 1995–2000*, technological innovation is the primary driving force behind recent productivity increases in the United States.[5] Strategies to build R&D/innovation capacity serve to complement and reinforce many conventional economic development strategies, and companies located in proximity to such research centers enjoy a competitive advantage. The Federal Reserve Bank of Cleveland determined the greatest factors driving state per capita income were those relating to a state's "innovation" and "workforce skills."[6]

Given the role that knowledge plays in fostering technological innovation and increased productivity, it is not at all surprising that a 1999 Milken Institute study, among others, has found that "research centers and institutions are undisputedly the most important factor in incubating high-tech industries."[7]

Where in the past, competition favored those localities with low wages, low infrastructure costs, and abundant natural resources, in the new economy the competitive edge has shifted toward localities offering the knowledge resources that nurture clusters of high-technology, high-growth services and industries. In addition, several studies have demonstrated that rural communities need not be shut out of this path toward future economic prosperity. As a result, state development policies have come to focus on "attracting talent, fostering interaction with the private sector, and cultivating a diversity of research industries."[8]

Increasingly, states have moved from a linear approach of funding university research to approaches that encourage public-private partnerships and focus on competitive investments with greater accountability. Ohio's $1.6 billion Third Frontier initiative is a comprehensive effort to build world-class research capacity while promoting interaction between research and industry to commercialize R&D results—including the six Wright Centers of Innovations funded at $147 million.

Knowledge has a "public good" quality because the aggregate benefits that research generates cannot be completely captured by the organization that produces the new knowledge. Research is an investment that pays off slowly over time as innovations are developed by scientists and adopted by end users, providing long-term economic benefits. As a result, the social returns earned by investments in research are likely to be much higher than the private returns a company could earn from such investments.

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[4] Council on Competitiveness, *Where America Stands: Entrepreneurship Competitiveness Index*, 2007. http://www.compete.org/publications/detail/29/competitiveness-index/ . Accessed March 20, 2008.
[5] McKinsey Global Institute, U.S. Productivity Growth: 1995–2000, October 2001. http://www.mckinsey.com/mgi/publications/us/ . Accessed March 20, 2008.
[6] Federal Reserve Bank of Cleveland, 2005Annual Report: "Innovation and Education are the Keys to Economic Growth," 2006. http://www.clevelandfed.org/Pubs/ARCurrent.cfm . Accessed March 20, 2008.
[7] DeVol, R. and P. Wong, "America's High-Tech Economy: Growth, Development, and Risks for Metropolitan Areas," Milken Institute, 1999. http://www.milkeninstitute.org/publications/publications.taf?function=detail&ID=15&cat=ResRep . Accessed March 20, 2008.
[8] Center for Best Practices, "Enhancing Competitiveness: A Review of Recent State Economic Development Initiatives – 2005," National Governors Association, May 8, 2006. http://www.nga.org/cda/files/0501COMPETITIVENESS.pdf . Accessed March 2009.

Metrics and Evaluation of Success

Technology-led economic development organizations are making major changes to how they define success and consequently to both the metrics they track and the ways they report them. Depending on the type of organization, preferred metrics for technology-based economic development and technology transfer organizations have traditionally included job creation or licensing income received. Current trends show organizations reevaluating that notion, on the basis of two primary arguments: 1) "success," as measured by these types of indicators may be at odds with the organization's broader mission (e.g., education/ training, public service); and 2) success in these categories is not wholly within the control of the organization. For these reasons, practitioners in the field are increasingly seeking to select and report measures that are better aligned with their mission and activities, and reflect factors within their purview or control. Some "lessons learned" from organizations that have recently re-evaluated their metrics follow.

Align metrics and reporting with the organization's goals, and with the priorities of the intended audience.

The metrics tracked by technology-based economic development and technology transfer organizations depend on their respective reasons for tracking. Motivations for tracking activities and outcomes vary by type of organization, and even from organization to organization within categories, depending on respective goals, structure, and reporting audience. Universities, for example, are more likely to track and report metrics with the goal of communicating the value of their department's activities, particularly to management, but also to research funders and policymakers, to ensure ongoing resources. Federal agencies and programs, however, are less focused on communicating value, and more on metrics that help predict commercialization success (e.g., a small business applicant's commercialization history or technical assistance to prepare a commercialization plan) and therefore help guide future award decisions and/or program offerings.

Align selection of metrics with the organization's activities and progress toward goals within its control.

A corollary to the previous lesson learned is that metrics should reflect 1) the full breadth of what the organization does, and 2) outcomes that are within the organization's control. A key part of the movement to update metrics, on the part of all of the organization types profiled, has been the notion that traditional metrics have tended to track outcomes and impacts that are outside the organization's purview or control. For example, the number of start-ups created is a commonly tracked and reported metric, but enterprise creation and survival is dependent on a host of factors outside any single organization's control (e.g., market forces, national economic conditions). The question becomes whether that sort of metric is reflective, then, of that organization's relative success.

"Old" economic development and technology transfer metrics tend to be overly "deal"-centered. Many innovation centers, federal labs, and universities increasingly focus more on relationship- and/or activity-centered metrics that reflect more of what is actually within the control of the organization.

Plan to continuously change and/or update the metrics the organization tracks.

As innovation-led economic development organizations and their activities "mature," their potential impact will change and expand; therefore, the metrics they use will necessarily change. For that reason, some organizations plan to proactively and continuously change the metrics they track. Job creation, for example, is often a "trailing indicator" (that is, it indicates success long after investments

are made and activities are initiated), not a "leading indicator" (which can provide a more timely snapshot of progress and success). This is particularly true in the case of innovation centers, where programs frequently involve technologies, entrepreneurs, and businesses at very early stages.[9]

In addition to updated metrics, consider nontraditional reporting/communication formats.

In addition to the fact that organizations are planning to implement or have implemented major changes to the metrics they track, many have also changed or expanded their reporting methods to include significant qualitative, narrative elements. These may include case studies or testimonials from industry partners, which are showcased in color brochures or annual reports, on Websites, or other interactive media such as CD-ROMs.

LESSONS AS APPLIED TO THE VIRGINIA REGIONAL ENERGY INNOVATION CENTERS INITIATIVE

Based on the benchmarking exercise and best practices research summarized herein, RTI developed business and operations plans for the three Regional Energy Innovation Centers that:

- Align the Initiative with existing assets in the respective regions, particularly the strengths (and needs) of existing industry, as well as with broader market trends and projections.
- Establish a strong case for state, private foundation, and industry support for the critical start-up and ramp-up years.
- Incorporate strong outreach components to maximize industry and regional university collaborations as well as workforce and economic development impacts.
- Structure the Initiative for oversight and leadership by a diverse array of skilled program administrators, technical experts and researchers, industry leaders, and key community stakeholders.
- Institute a framework for tracking, measuring, and reporting progress and success to funders and other stakeholders from inception, as detailed below.

The Virginia Regional Energy Innovation Centers Initiative proposed a full range of metrics that could shift or expand through the course of the centers' development. These included activity/input measures as well as impact/output measures, and incorporated both quantitative measures such as number of patent applications and qualitative measures such as industry's perceived value of Center program offerings. A summary of proposed metrics follows.

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[9] Pennsylvania Department of Community and Economic Development, "Measuring Up: Enhanced Metrics for a New Economy" http://www.newpa.com/build-your-business/locate/key-industries/high-technology/technology-based-economic-development-partners/index.aspx Accessed March 2009.

Category	Example of Performance Metric
Activity/Input Measures	Number of companies directly involved in Center programs Number of workers participating in workforce & education programs
R&D Capacity	Total R&D Awards Annual R&D Expenditures
Innovation	Number of patent applications and issues, license agreements, and new products developed Number of spin-off companies
Operations	Leverage of state funding: $ amount of funding from other sources per $ invested by the state Industry satisfaction and perceived value of programs
Regional Economic Impact	Number of jobs directly related to the Center Job retention and wage levels of companies involved with the center Regional and state economic impact of center (every three years)

Using these detailed business and operations plans, the three innovation centers jointly sought and received $24 million in construction funds. Reportedly, the centers are now positioned to receive significant, additional funds for start-up operations. The three physical facilities are in various stages of planning and development, and the innovation centers have forged ahead, establishing partnerships and research agreements with universities, industry, and federal labs.

The investments in the Innovation Centers will create significant impact on each of the targeted energy industry sectors—coal, nuclear, and bioenergy—and regional economies within the five-year planning horizon. Construction funding will provide new, state-of-the-art facilities for the R&D and education programs as well as enable other available funding to go directly to programmatic efforts rather than to debt service.

The new technologies that will emerge from the Initiative will make a vital contribution to the effort to significantly reduce emissions of carbon dioxide and other greenhouse gases. The United States' heavy dependence on energy imported from increasingly unstable areas of the world has created an environment where energy policy is now closely linked to national security policy. This Initiative offers a significant contribution in providing the country, and more specifically Virginia, with alternative domestic sources of energy.