



WEST VIRGINIA BLUEPRINT FOR  
TECHNOLOGY-BASED ECONOMIC DEVELOPMENT

ADVANCED ENERGY

March 2009



A report from: **TechConnectWV**

West Virginia Coalition for Technology Based Economic Development

With consultation and assistance from:

**Battelle Technology Partnership Practice**

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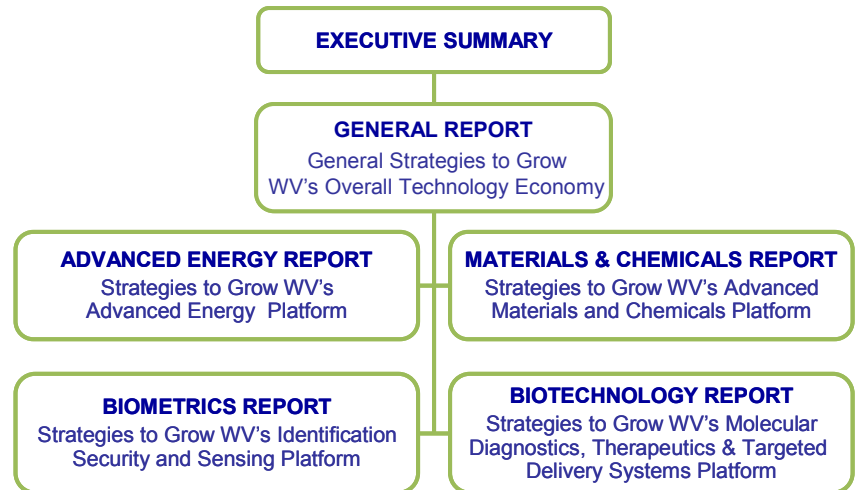
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## HOW THIS REPORT IS ORGANIZED

This report represents Phase II of West Virginia's Technology-Based Economic Development (WV's TBED) Blueprint. In 2007, Battelle Technology Partnership Practice produced the Phase I report entitled *Gap Analysis and Identification of Strategic Technology Platforms*.

The Phase II study is organized into six distinct reports:

- Executive Summary** — Provides a synopsis of introductory and background material, general strategies and actions for growing West Virginia's technology economy, and specific strategies and actions for growing West Virginia's Advanced Energy and "Biometrics" (Identification, Security, and Sensing Technology) sectors
- General Report** — Includes the Executive Summary, but also provides detailed introductory and background material and detailed information on the general strategies and actions for growing West Virginia's technology economy
- Advanced Energy Report** — Provides detailed information on the specific strategies and actions for growing West Virginia's Advanced Energy sector
- "Biometrics" Report** — Provides detailed information on the specific strategies and actions for growing West Virginia's Identification, Security, and Sensing Technology sector
- Advanced Materials and Chemicals Report** — Provides detailed information on the specific strategies and actions for growing West Virginia's Advanced Materials and Chemicals sector
- "Biotechnology" Report** — Provides detailed information on the specific strategies and actions for growing West Virginia's Molecular Diagnostics, Therapeutics, and Targeted Delivery Systems sector



The general strategies and actions represent broad recommendations for West Virginia's overall technology economy. They are common activities and tasks that will boost TBED in West Virginia independent of and across all technology areas.

Conversely, the specific sector strategies and actions are recommendations explicitly targeted to four, pre-identified technology strength areas in West Virginia. They represent those activities and tasks that will enhance those particular technology platforms.

Thus, the general strategies and actions are common to all four technology sectors and to other technology areas as well.

While many of the specific sector strategies and actions are unique to particular technology areas, there are common or similar recommendations and thus overlap among the

technology platforms. Likewise, there are some common recommendations and overlap between the general and specific sector strategies and actions as well.

As of March 2009, the first four of the six reports have been completed. However, TechConnectWV plans to develop strategies and actions for the other two technology platforms — (1) Advanced Materials and Chemicals and (2) Molecular Diagnostics, Therapeutics, and Targeted Delivery Systems — over the coming months.

*This report is the **ADVANCED ENERGY REPORT** only.*

This report and all other reports can be found at:  
[www.TechConnectWV.com](http://www.TechConnectWV.com)

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## MEASURES OF SUCCESS

The ultimate measures of success — or outcomes — of the recommended strategies and actions will reflect the work of many groups, organizations, companies and individuals. No one person or organization will be solely responsible for the overall results — increased investment in technology-based research, development, and commercialization and increased numbers of jobs and new companies in the technology sector in West Virginia. However, **to promote accountability, lead organizations have been recommended** for all actions identified in the strategy.

Likewise, these **outcomes will not come from one particular strategy or action**. Instead, the various strategies and actions will work together to produce the overall results — an overall boost in TBED in the state.

Still, **some actions will impact some outcomes more directly than others**. Thus, those measures of success that will likely be most influenced by a particular action item are also listed as outcomes of that particular action. Consequently, each outcome is listed multiple times under both the general strategy below and the platform strategies that follow.

**Specific measures of success** are listed below for the overall Blueprint (and again, are also listed under specific actions where appropriate).

- Continue to **grow the West Virginia academic R&D base** at a pace that significantly exceeds that of the nation with a target of \$360 million by 2015
  - *Between 2006 and 2007, R&D at West Virginia's universities and colleges increased by 11.1% while total U.S. academic R&D increased by 3.5%*
  - *Between 2002 and 2007, R&D at West Virginia's universities and colleges increased an average of 10.9% per year while total U.S. academic R&D increased an average of 6.3% per year*
  - *The \$360 million target represents an increase of just over 10% per year, roughly equivalent to the 10.9% average from 2002 to 2007*
  - *Recent West Virginia academic R&D:*
    - 2002: \$100,830,000
    - 2003: \$125,417,000
    - 2004: \$134,961,000
    - 2005: \$146,489,000
    - 2006: \$150,420,000
    - 2007: \$167,208,000
  - *The past growth in West Virginia R&D occurred at a time of increasing federal R&D budgets, including the doubling of NIH funding; future funding will be highly dependent on the growth of future federal R&D funding*
- **Increase R&D funding in platform areas** in all sectors (academia, nonprofits, and industry)
  - *Because no current baseline data exist, there is a need to track over time and form more specific goals as data are gathered*

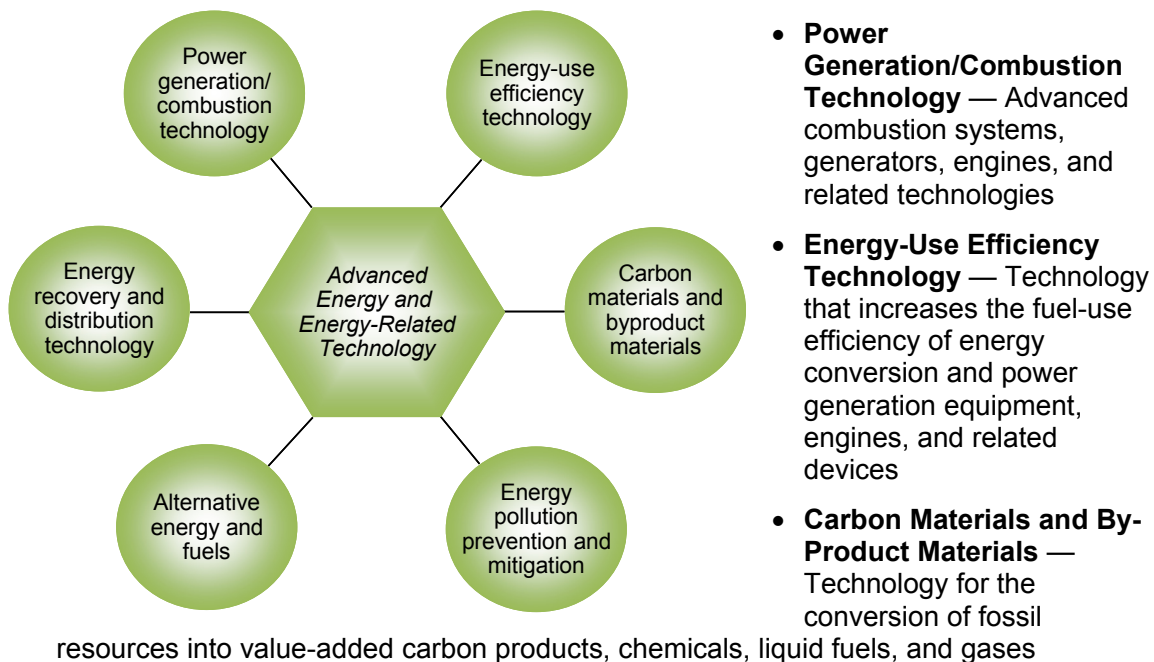
- **Increase industry-supported R&D** at West Virginia's universities and colleges to match the national average by 2020
  - *In 2007, 3.3% of total R&D expenditures at West Virginia colleges and universities came from industry, compared with 5.4% in the United States*
  - *From 2002 to 2007, an average of 3.4% of total R&D expenditures at West Virginia colleges and universities came from industry, compared with 5.3% in the United States.*
- **Increase the number of technology-based companies** in West Virginia at a rate higher than the national average
  - *Because no current baseline data exist, there is a need to track over time and form more specific goals as data are gathered*
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach national average by 2020
  - *In 2005, 8.1% of West Virginia's total employment was in the high-tech sector, compared with the national average of 10.9%*
  - *It may be helpful to consider other measures, such as employment in platform areas or particular industry sectors related to the platforms*
- **Increase the number of spin-off companies** developed from technology created at West Virginia's universities to achieve the national average by 2020
  - *Current national average is one spin-off company created for every \$88 million of academic R&D*
  - *The measure would correspond to about two new start-ups created per year at current academic R&D funding levels*
  - *The measure would correspond to about four new start-ups created per year if academic funding reaches \$360 million in 2015*

## Technology Platform Strategies and Actions for Boosting Technology-Based Economic Development In West Virginia

### **Advanced Energy and Energy-related Technology**

The Advanced Energy and Energy-Related Technology platform focuses on multiple opportunities in research and development (R&D) and technology development applications related to **both fossil and renewable energy sources**. Chief among the goals of such a platform should be to increase the value-added economic activity based on energy resources — developing high-value liquid fuels from carbon products, carbon-based chemicals, and advanced technologies for high-efficiency combustion, fuel conversion, pollution control, and energy transmission. Figure E-1 and the following descriptions illustrate the **areas of R&D-driven technology development opportunities envisioned** under the platform in the Phase I study.

**Figure E-1. Opportunities of Advanced Energy and Energy-Related Technology Platform**



- **Power Generation/Combustion Technology** — Advanced combustion systems, generators, engines, and related technologies
- **Energy-Use Efficiency Technology** — Technology that increases the fuel-use efficiency of energy conversion and power generation equipment, engines, and related devices
- **Carbon Materials and By-Product Materials** — Technology for the conversion of fossil resources into value-added carbon products, chemicals, liquid fuels, and gases
- **Energy Pollution Prevention and Mitigation** — Advanced technologies for reducing or eliminating polluting emissions from energy production and consumption activities
- **Alternative Energy and Fuels** — Development of advanced and alternative fuel and energy generation technologies such as fuel cells
- **Energy Recovery and Distribution Technology** — Technology to enhance the recovery, distribution efficiency, reliability, and security of fossil resources

Importantly, the expertise within the state is so broad — and the needs of the nation so vast — that there **will be additional opportunities beyond those identified above**.

Advanced Energy and Energy-Related Technology was **selected as one of two platforms** to initially develop strategies and actions for several reasons:

- **Energy production is a critically important driver** of the West Virginia economy with a robust industry base in the sector providing broad, multicounty benefits
- The value of **West Virginia’s large-scale fossil-fuel resources are threatened** by concerns over carbon dioxide emissions and global warming, so the development of new technology to mitigate this is critically important to the state
- Commercialization of **advanced energy and energy-related products will add value** to existing West Virginia resources, thereby expanding the state economy (producing liquid fuels and chemicals from coal, for example, adds substantial value for coal)

**West Virginia’s Coal Industry**

- ✓ Generates more than **\$3.5 billion annually** in gross state product
- ✓ Directly accounts for over **40,000 jobs**
- ✓ Accounts for **\$2 billion annual payroll**
- ✓ Accounts for **two-thirds of business taxes** paid in the state

- **West Virginia has a strong base of energy R&D** at the National Energy Technology Laboratory (NETL) and West Virginia University (WVU), and private sector R&D at MATRIC, raising West Virginia’s profile in alternative fuels and fossil-fuel chemical coproducts

- **R&D collaborations are occurring across state lines** between West Virginia and southwestern Pennsylvania research institutions, expanding research capabilities and applying funding leverage from at least two states
- **Energy is a key national strategic priority** and is likely to benefit from significant investment in R&D and infrastructure funding over the coming years.

In fact, **coal drives much of West Virginia’s economy** and drives a vertically integrated energy industry in the state, with 99% of West Virginia’s electricity generated by coal-fired generating facilities.

The state produces far more coal than needed for in-state uses and ranks as the **leading coal-exporting state in the nation**, with over 50 million tons shipped to 23 countries annually.

West Virginia’s **oil and natural gas** reserves are also significant, and the industry is a **major driver in the state’s economy**.

With the need for energy independence and security across the nation, the state’s energy resources will become more important and strategic over the coming years.

Energy independence, alternative energy sources, clean coal technology, and global climate change have received considerable attention in recent years. Advanced energy research has also been noted as a key platform for strategic priority investments by President Barack Obama. **West Virginia is positioned at a unique time in history to further advance its economy around advanced energy and energy-related technologies.**

**Three strategies and 13 actions**, summarized in Figure E-2 and detailed below, are proposed to grow West Virginia’s energy economy. Actions marked critical are those that have the greatest priority, although some may take several years to accomplish. Immediate actions are those that should be undertaken in the first year of implementation. Short-term

**West Virginia’s Oil and Natural Gas Industry**

- **Only net exporter** of natural gas east of Mississippi
- State contains **40,500 natural gas wells**
- Annual production of **191.6 billion cubic feet of gas**
- State contains **7,500 oil wells**
- **Annual production of 1.9 million barrels of crude oil**

actions should be undertaken in 1 to 3 years, and mid-term actions should be undertaken in 3 to 5 years.

**Figure E-2. Overview of Energy Platform Strategies and Actions**

Bring key stakeholders together to guide advanced energy sector development	Establish West Virginia as a leader in advanced energy	Facilitate university, national lab, and nonprofit engagement with industry for technology development and commercialization
<ul style="list-style-type: none"> <li>▪ Form platform steering committee comprising representatives from industry, government, and R&amp;D institutions</li> <li>▪ Develop opportunities and high-value technology areas with alignment to existing energy-related statewide strategic plans</li> <li>▪ Develop key stakeholder groups or subcommittees that are chartered with developing and implementing plans, projects, or activities focused on specific high-priority theme areas (e.g., clean coal technology, carbon sequestration, combustion technology)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Build an active and strong portfolio of advanced research projects funded by the federal government under its advanced energy program initiatives</li> <li>▪ Establish a significant level of nationally known technology programs funded by industry and venture capital firms</li> <li>▪ Develop capability to write position papers on economic and/or policy issues related to energy across the spectrum of state government, universities, nonprofits, and industry sectors</li> <li>▪ Take a leadership role in promoting interstate programs for energy research, demonstration, or deployment of advanced technologies</li> <li>▪ Implement advanced energy initiatives throughout governmental, government-related, industrial, and private sector sites to promote energy conservation and efficiency or deploy more environmentally friendly technologies</li> <li>▪ Increase West Virginia’s non-fossil fuel and energy portfolio</li> </ul>	<ul style="list-style-type: none"> <li>▪ Hold a series of forums/events in which energy-sector industry representatives outline their needs to the university, national lab, and nonprofit research leaders</li> <li>▪ Seek establishment of a nationally recognized (such as NSF) industry-university collaborative center in advanced energy technologies to be located at WVU and to focus on commercialization</li> <li>▪ Encourage commercialization of intellectual property from the National Energy Technology Laboratory</li> </ul>



**ENERGY STRATEGY ONE**

Bring key stakeholders together to guide advanced energy sector development

**Rationale:** West Virginia contains multiple organizations engaged in various aspects of energy R&D, energy resource development, energy production and distribution, and energy regulation. Several organizations have recently produced **plans or strategies targeting energy-based development in the state** including, for example:

- **West Virginia University** — *A Strategic Plan for the Advanced Energy Initiative*, August 2008
- **Imagine West Virginia** — *Coal: Energy, the Environment and West Virginia — Policy Recommendations*, April 2008
- **Governor’s Energy Task Force** — *West Virginia’s Energy Roadmap 2001–2020*, August 2002.

In addition, there have been **strategic priorities set by NETL and by CWP Inc.** Surrounding states have coal and other energy utilization and R&D strategies in place as well.

These R&D and overall energy development **strategies should be integrated into an overall prioritized strategic plan** for the West Virginia Advanced Energy and Energy-Related Technology platform.

**Alternatively, the various statewide energy plans should at least be aligned with one another** with enough collaboration and crossover to ensure the most efficient use of resources. This must be done in consultation with industry to gain commercial market perspectives on potential technology areas and with statewide stakeholders to gain strategic and macroeconomic perspectives. Expanding West Virginia's R&D base in energy research brings positive economic benefits through attracting external research funds; but, **ultimately, the main focus of the platform needs to be the generation of large-scale economic benefits through value-added products from in-state energy resources.**

#### CWP Inc.

- **Consortium for energy R&D** comprising three universities — **Carnegie Mellon** University, the University of **Pittsburgh**, and **WVU**
- Will receive up to **\$26 million in funding** over the next 2 years to develop clean and efficient technologies for the use of fossil fuels
- Will leverage each university's strengths in a close working relationship with the **NETL**

#### **Action E1.1: Form platform steering committee comprising representatives from industry, government, and R&D institutions**

*This action is also described in the General Report (see Action Eight).*

Battelle's experience with many TBED projects across the United States shows that a **formal organization needs to be formed that comprises leaders from key stakeholder groups within the platform area**. Working together, these leaders evaluate and prioritize platform development initiatives and present a united front in promoting priority projects and securing funds from key external sources.

The steering committee can be quite large, including 15 to 20 individuals. The group should plan on meeting monthly or bimonthly in the initial year to develop an aggressive implementation plan.

**Resources Required:** Funding to provide staff support could be included in the overall TechConnectWV budget. Alternatively, \$35,000 per year is recommended for a part-time position in support of committee administrative and organizational functions and for meeting support.

**Priority:** Critical

**Time Frame:** Immediate

**Recommended Lead Organization:**

TechConnectWV to take responsibility for forming the steering committee

**Intended Outcomes:**

- Continue to **grow the West Virginia academic R&D base** at a pace that significantly exceeds that of the nation, with a target of \$360 million by 2015

#### **Energy Platform Steering Committee Should Include Statewide Leaders From...**

- **Energy Industry** — technology and equipment manufacturers, resource extraction companies, energy production and distribution industries
- **Federal Research Laboratories** — primarily NETL, but others could be engaged such as the National Renewable Energy Laboratory
- **West Virginia Research Universities** — and those outside of the state that collaborate with West Virginia universities and NETL in energy research and development arenas
- **Government** — including representatives from the State of West Virginia and Congressional Delegation offices
- **Economic Development Groups** — state and regional organizations, agencies, and sponsors

- **Increase R&D funding in platform areas** in all sectors (academia, nonprofits, and industry)
- **Increase industry-supported R&D** at West Virginia's universities and colleges to match the national average by 2020
- **Increase the number of technology-based companies** in West Virginia at a rate higher than the national average
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach the national average by 2020
- **Increase the number of spin-off companies** developed from technology created at West Virginia's universities to achieve the national average by 2020

**Action E1.2: Develop opportunities and high-value technology areas with alignment to existing energy-related statewide strategic plans**

**West Virginia is well placed with its R&D organizations and industry to pursue multiple energy-related projects.** Under the guidance of the Platform Steering Committee, one of the first tasks is a prioritization of opportunities and focus areas. Deciding which to focus on should be based on rational economic impact decisions — with the main emphasis on projects that will add or preserve large-scale economic impacts in West Virginia, especially those that will create expanded job opportunities in value-added energy and energy-technology products. **Some of the areas for consideration** identified during Battelle's interviews and focus groups are as follows:

- Coal-to-Liquid Fuels (coal liquefaction)
- Coal-to-Gas Fuels (coal gasification)
- Coal to Chemicals (carbon-based chemicals)
- Coal Bed Methane (methane recovery) — could be used for other energy industries as part of cap-and-trade carbon management
- Coal Waste Utilization (gobs and fines)
- Clean Coal
- Carbon Capture and Sequestration
- Enhanced Oil Recovery
- Coal to Hydrogen Gas
- Biofuels — Cellulosic Ethanol
- Combustion Technology and Engine Efficiency
- Natural Gas Recovery and Advanced Technology.

**Areas targeted by CWP Inc. should be considered as well.** CWP will focus on research relating to the extraction and utilization of fossil fuel energy resources. The three universities in the partnership selected eight program areas emphasizing basic and applied research across a broad range of energy production and use applications. The consortium will work in close collaboration with NETL scientists and researchers.

The Advanced Energy Working Group, meeting for the first time during a focus group session for this Blueprint, emphasized bringing key stakeholders together to reach agreement on major issues that impact multiple parties (rather than just one or two companies).

The **Advanced Energy Working Group** (which should form the basis of the Advanced Energy Platform Steering Committee)

**Program Areas for CWP Inc.**

1. Materials for energy technologies
2. Process and dynamic systems modeling
3. Catalyst and reactor development
4. Carbon management
5. Sensor systems and diagnostics
6. Energy conversion devices
7. Gas hydrates
8. Ultradeep and unconventional oil and gas production technology

suggested the following areas of emphasis:

- **Carbon dioxide (CO<sub>2</sub>) capture and sequestration** — federal action is needed on stored CO<sub>2</sub> liability and other policy issues before real movement will occur
- **Creation of value-added products from coal** — not just in terms of energy products, but also chemicals and materials
- **Development of enhanced extraction technologies** to improve productivity in coal mining and other fossil fuel resources
- **Opportunities to link West Virginia biomass and coal usage** to offset CO<sub>2</sub> and other environmental issues
- **Development of waste-stream technologies** to create value from mining and other energy-production waste streams

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The Focus Group participants (Advanced Energy Working Group) agreed with the idea of that group forming the basis of the Advanced Energy Platform Steering Committee. They favored continued meetings of key stakeholders to develop action priorities and suggested closer working relationships be established between academic and NETL researchers and West Virginia–based industry and industry associations.

**Resources Required:** \$50,000 in consulting support and analytical services for prioritizing technology focus areas by potential economic impact. An organization such as the West Virginia Regional Research Institute, working in consultation with the National Research Center for Coal and Energy (NRCCE) at WVU, would have the required expertise for this evaluation.

**Priority:** High

**Time Frame:** Short-term

**Recommended Lead Organization:** Advanced Energy Platform Steering Committee

**Intended Outcomes:**

- Continue to **grow the West Virginia academic R&D base** at a pace that significantly exceeds that of the nation, with a target of \$360 million by 2015
- **Increase R&D funding in platform areas** in all sectors (academia, nonprofits, and industry)
- **Increase industry-supported R&D** at West Virginia's universities and colleges to match the national average by 2020
- **Increase the number of technology-based companies** in West Virginia at a rate higher than the national average
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach the national average by 2020
- **Increase the number of spin-off companies** developed from technology created at West Virginia's universities to achieve the national average by 2020

***Action E1.3: Develop key stakeholder groups or subcommittees that are chartered with developing and implementing plans, projects, or activities focused on specific high priority theme areas (e.g., clean coal technology, carbon sequestration, combustion technology, etc.)***

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*It is recommended that this action take place AFTER E3.1, if possible. E3.1 would create a series of forums/events in which energy-sector industry representatives outline their needs to the university and national lab research leaders. This item would then follow those forums/events. It also recommended that, if possible, this be done after creating a university-industry matching grant program (Action Four in the General Report) to create an additional, concrete pull for university-industry interactions.*

As demonstrated in Action E1.2, **there are likely to be many areas of technology development and commercialization opportunities.** However, the opportunities and needs in one area may be very different than in another. For example, advanced carbon capture and sequestration technologies may have very different researchers, sponsoring agencies, and industry partners than would cellulosic ethanol. The technologies, needs, markets, etc., vary from one opportunity area to another; therefore, the **highest-priority project areas will need to have their own subcommittees** to guide their development.

Once the primary high-impact opportunities have been identified under the guidance of the main Platform Steering Committee, it will be necessary to form subcommittees for work in each area. Membership of the subcommittee may include some of the main Platform

Steering Committee members, but may also be significantly expanded by researchers, stakeholders, and industry representatives specific to that subcommittee focus.

**Resources Required:** Variable depending on the needs of individual subcommittees

**Priority:** High

**Time Frame:** Short- to mid-term

**Recommended Lead Organization:** Advanced Energy Platform Steering Committee

**Intended Outcomes:**

- Continue to **grow the West Virginia academic R&D base** at a pace that significantly exceeds that of the nation, with a target of \$360 million by 2015
- **Increase R&D funding in platform areas** in all sectors (academia, nonprofits, and industry)
- **Increase industry-supported R&D** at West Virginia's universities and colleges to match the national average by 2020
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	<p>ENERGY STRATEGY TWO</p>	<p>Establish West Virginia as a leader in advanced energy</p>
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**Rationale:** For the first time since the fuel crisis of 1973, **the American public has turned its attention to energy** and energy prices as a leading economic issue for the nation. Energy is a primary point of **emphasis in the new administration** of President Obama as well, with impetus coming not only from consumer concerns over rising energy prices, but also from concerns over domestic energy security and global climate and environmental security.

President Obama's "*New Energy for America Plan*" proposes **significant investment in energy R&D**, new technology deployment, and infrastructure expansion.

**President Barack Obama's  
"New Energy for America Plan"**

- Proposes strategic investment of **\$150 billion over the next 10 years to catalyze private efforts** to build a clean energy future
- Offers investments in: (1) **basic research**, (2) **technology demonstration**, and (3) **aggressive commercial deployment**
- Proposes to **develop and deploy clean coal technology**
- Recommends development of technologies to **employ carbon dioxide as a tool** for extracting oil stranded in existing oil fields
- Plans investment in a **smart grid** to transmit and monitor electricity more efficiently

Clearly, **West Virginia’s energy strengths** — its vast energy resources, strong energy industry, and robust energy research — **put the state in a favorable position to take a leadership role for advanced energy** both nationally and globally. In fact, the state should be a leader in implementing the Obama energy plan. While it is unrealistic to expect all of the Obama plan will be implemented, it is

**WVU Advanced Energy Initiative Vision**  
 “West Virginia University will become **internationally** recognized as a **leading academic institution** driving innovative research in the socially and environmentally responsible production, management and utilization of **energy**.”

reasonable to anticipate that **those states that assemble a suite of prioritized projects that match the stated goals of the new administration are likely to benefit.** The presence of NETL, strong research at WVU, major energy assets and industry in West Virginia, collaboration with major research universities, coupled with the strength of the Democratic West Virginia Congressional Delegation, bode well for the state assuming a leadership role.

- Imagine West Virginia**  
**Coal: Energy, the Environment and West Virginia —**  
**Policy Recommendations, April 2008**
1. Strengthening coal-related research
  2. Promoting expertise in mining safety and remediation
  3. Developing the next generation of coal leadership
  4. Training tomorrow’s coal-related workforce
  5. Fostering new coal-related business enterprises
  6. Engaging in more strategic regional collaborative initiatives
  7. Building greater advanced coal technology capabilities
  8. Establishing a coalition for global efforts in coal
  9. Participating in effective organizations that advance coal
  10. Creating an independent energy advisory body

While other states and research institutions are focusing on renewable energy sources to expand R&D, **fewer states are viewing fossil fuel resources as a future development asset.**

The truth is, however, that **fossil fuels are not going to be replaced any time soon.** They are plentiful and comparatively inexpensive; but, new technologies for recovery, production and use, and environmental mitigation must be developed to sustain the fossil fuel industry and meet administration goals.

**West Virginia is positioned to work on these issues and become a global leader in advanced energy production and use.**

***Action E2.1: Build an active and strong portfolio of advanced research projects funded by the federal government under its advanced energy program initiatives (fundamental R&D, demonstrations, and commercialization programs)***

WVU, the State of West Virginia, and NETL have all taken leading roles in establishing, supporting, or promoting energy research in the state.

In fact, **WVU** has already moved to establish a leadership role in energy research with the **Advanced Energy Initiative Strategic Plan.**

Significantly, the plan was written to address major energy issues in the nation and to engage in federal government priorities and initiatives. Notably, the plan includes both fossil and sustainable energy research but also energy policy.

- WVU Advanced Energy Initiative Strategic Plan**  
**Three Major Focus Areas**
- 1. Fossil Energy:** *Fossil Energy Resources, Conversion, Utilization, Sequestration, and Environmental Management*
  - 2. Sustainable Energy:** *Energy Efficiency, Conservation, and Renewable Energy*
  - 3. Energy Policy and Regulatory Affairs:** *Analysis of Energy Policy, Carbon Management, Environmental, and Infrastructure Issues*

The **State of West Virginia** has published an energy plan as well. And the **NETL** in Morgantown continues to contribute to the nation’s strategic energy goals by providing cutting-edge R&D.

In fact, **NETL will no doubt be actively engaged** in both plans and implementation of new energy initiatives as the U.S. Department of Energy (DOE) develops its plans in concert

**State of West Virginia Energy Plan Emphasizes...**

- ✓ Enhanced **production of fossil energy** sources including advanced coal technologies
- ✓ Renewable and **alternative energy** development
- ✓ Energy **efficiency**

with the new federal administration. It will be important for West Virginia’s leadership to stay actively connected with NETL, supporting its plans and activities, especially since NETL has a strong fossil fuel focus and an existing commitment to work with area research universities.

However, although West Virginia is already active and a leader in energy research, the state is **not as active in technology transfer and commercialization** of new energy technologies.

This is an area that the **state must improve to fully participate** in advancing the energy economy in the nation and to become a global leader in energy innovation.

**The following plans are recommended** to help West Virginia build an active and strong portfolio of advanced research projects funded by the federal government:

1. West Virginia **leaders become directly engaged in the new administration’s formulation and implementation of energy policy.** A key action will be to proactively seek an in-depth understanding of administration priorities, be engaged in the development of those priorities, and form a leadership position for West Virginia in those areas that match to the high-impact project areas identified under Action E1.2.

2. West Virginia **leaders move quickly to identify projects,** initiatives, and areas that fit both West Virginia’s strengths and priorities and federal priorities. With early indication suggesting that the new administration will be funding basic research, technology demonstration, and aggressive commercial deployment, West Virginia needs to move quickly to accomplish the following:

**NETL’s Key Issues and Mandates**

- **Secure and Reliable Energy Supplies** — Advancing cost-effective and environmentally sound technologies for finding and producing domestic coal, oil, and natural gas
- **Clean Power Generation** — Developing and demonstrating technology for the efficient and reliable use of fossil resources, including efforts to make today’s coal power plants cleaner
- **Toward a Hydrogen Economy** — Developing cost-effective ways to obtain hydrogen from domestic coal and natural gas for power generation from fuel cells
- **Climate Change** — Providing technology options for clean power generation and the monitoring, capturing, and sequestering of greenhouse gases

<i>Identify priority project areas with high economic impact for West Virginia</i>	+	<i>Identify those West Virginia priority project areas that match new and existing major federal energy funding priorities</i>	=	<i>Finalize prioritized list of projects to move forward in near to mid term</i>
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3. West Virginia leaders **engage the West Virginia Congressional Delegation,** together with state government, to make West Virginia’s case for major project funding. This action step may not need a heavy emphasis if the preceding action is successful — West Virginia identifies priority projects that are in alignment with federal goals. Still, competition for project funding will be competitive and challenging; but,

given the strength of West Virginia’s Congressional Delegation and the importance of the energy sector to the state’s economy, this should be a high-priority area for the state’s Congressional Delegation.

With continued emphasis in energy research at WVU, NETL, the State of West Virginia, and other organizations in the state such as MATRIC and other universities — and with a new emphasis on energy technology commercialization — **West Virginia can be a leading player** in the federal government’s desire for a more secure energy future for the nation.

**Resources Required:** Research and public policy support service may be conducted by Advanced Energy Platform Committee members and related institutions

**Priority:** High

**Time Frame:** Short-term

**Recommended Lead Organizations:** Advanced Energy Platform Steering Committee, WVDO, West Virginia Division of Energy, and West Virginia Congressional Delegation

**Intended Outcomes:**

- Continue to **grow the West Virginia academic R&D base** at a pace that significantly exceeds that of the nation, with a target of \$360 million by 2015
- **Increase R&D funding in platform areas** in all sectors (academia, nonprofits, and industry)
- **Increase the number of technology-based companies** in West Virginia at a rate higher than the national average
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach the national average by 2020

### ***Action E2.2: Establish a significant level of nationally known technology programs funded by industry and venture capital firms***

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As mentioned above, West Virginia has a strong base in energy research, but not necessarily in energy innovation — the transfer and commercialization of energy technology.

This action would bring West Virginia’s current and future focus on energy research into the commercial realm to **help drive both West Virginia’s technology economy and the nation’s energy agenda**.

This effort will require an ever-increasing focus on the commercialization aspects and potential of the state’s energy research programs and activities in both academia and the federal labs. Battelle proposes a **stronger collaboration and engagement** of WVU’s energy research activities **with the private sector**, including the energy industry but also organizations dedicated to commercializing technology, like MATRIC.

**Resources Required:** Should be included in TechConnectWV budget (and related organizations’ budgets for any support activities)

**Priority:** High

**Time Frame:** Mid- to long-term

**Recommended Lead Organizations:** Advanced Energy Platform Steering Committee

**Intended Outcomes:**

- Continue to **grow the West Virginia academic R&D base** at a pace that significantly exceeds that of the nation, with a target of \$360 million by 2015
- **Increase R&D funding in platform areas** in all sectors (academia, nonprofits, and industry)

- **Increase industry-supported R&D** at West Virginia's universities and colleges to match the national average by 2020
- **Increase the number of technology-based companies** in West Virginia at a rate higher than the national average
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach the national average by 2020
- **Increase the number of spin-off companies** developed from technology created at West Virginia's universities to achieve the national average by 2020

***Action E2.3: Develop capability to write position papers on economic and/or policy issues related to energy across the spectrum of state government, universities, nonprofits, and industry sectors***

For West Virginia to be a leader in advanced energy, it must have groups, organizations, and individuals who are **thought leaders** in the area. According to Elise Bauer, a business and marketing strategies advisor for technology companies, a distinguishing characteristic of a thought leader is “the **recognition from the outside world that the [organization or person] deeply understands** its business, the needs of its customers, and the broader marketplace in which it operates.”<sup>1</sup>

That recognition from the outside world that West Virginia is a thought leader in advanced energy research and commercialization would go a long way to making the state a true leader in the area.

Moreover, thought leadership is a vital driver of success, providing guidance and direction but also influencing strategies and goals and other leaders' actions. Thought leaders help set agendas. More specifically, **energy policy studies drive economic actions in the energy area.**

The Advanced Energy Working Group proposed the development of a “think tank” for Advanced Energy in West Virginia.

The WVU Advanced Energy Initiative also has a related objective as one of its focus areas — **Energy Policy and Regulatory Affairs.**

**WVU Advanced Energy Initiative  
Strategic Plan**

**Goals for Energy Policy and  
Regulatory Affairs**

- ✓ Form a broad **interdisciplinary policy team** to identify critical issues
- ✓ Develop **major research programs**
- ✓ Develop a macroeconomic modeling program for energy systems

**Resources Required:** Research and public policy support service may be conducted by Advanced Energy Platform Steering Committee members and related institutions (especially WVU)

**Priority:** High

**Time Frame:** Short-term

**Recommended Lead Organizations:** Advanced Energy Platform Steering Committee and WVU Energy Policy Leaders

**Intended Outcomes:**

- Continue to **grow the West Virginia academic R&D base** at a pace that significantly exceeds that of the nation, with a target of \$360 million by 2015
- **Increase R&D funding in platform areas** in all sectors (academia, nonprofits, and industry)
- **Increase industry-supported R&D** at West Virginia's universities and colleges to match the national average by 2020

<sup>1</sup> Elise Bauer, “Be A Thought Leader!,” posted November 10, 2003, at <http://www.elise.com>.

- **Increase the number of technology-based companies** in West Virginia at a rate higher than the national average
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach the national average by 2020
- **Increase the number of spin-off companies** developed from technology created at West Virginia's universities to achieve the national average by 2020

***Action E2.4: Take a leadership role in promoting interstate programs for energy research, demonstration, or deployment of advanced technologies***

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For West Virginia **to be a national or even global leader in advanced energy**, the state must not only collaborate nationally (and even globally) but also be a leader to **promote and forge national collaborations**. Highly innovative technology development and commercialization will require the best and brightest minds from around the country. That, in turn, will require West Virginia's best and brightest to join forces with those in surrounding states.

Likewise, interstate partnerships and efforts will provide additional opportunities for industrial collaborations, giving West Virginia and other partners access to business and industry located in other states and regions.

**CWP Inc. is an excellent example** of the type of collaborations that are needed. The consortium of three universities — Carnegie Mellon University, the University of Pittsburgh, and WVU — will provide enhanced opportunities for energy research.

However, the programs intended in this action do not have to be as significant or formal as CWP Inc. Small and large programs and activities should be encouraged and implemented between and among various organizations. They can be as large as CWP Inc. or as small as one-to-one collaborations between two researchers at different institutions. On the other hand, unlike CWP Inc., many of these programs should focus not only on energy research, but also on commercialization of energy technology.

West Virginia is not alone in having fossil fuel assets and associated R&D assets that can be brought to bear on key energy issues. Surrounding states share coal resources along the Appalachian chain and also share concerns for their energy and economic future.

**Major energy companies operating in West Virginia are also multistate** in nature, with major companies such as CONSOL, AEP, and Equitable Gas having key assets, and therefore interests, across multiple states.

Therefore, **Battelle recommends that the Advanced Energy Platform Steering Committee examine potential collaborations** with surrounding states in areas that would benefit all and enhance the likelihood of successful federal appropriations and industry support.

**Resources Required:** Support may be provided by Advanced Energy Platform Steering Committee members and related institutions (especially WVU and CWP Inc.)

**Priority:** High

**Time Frame:** Short- to mid-term

**Recommended Lead Organization:** Advanced Energy Platform Steering Committee

**Intended Outcomes:**

- Continue to **grow the West Virginia academic R&D base** at a pace that significantly exceeds that of the nation, with a target of \$360 million by 2015
- **Increase R&D funding in platform areas** in all sectors (academia, nonprofits, and industry)
- **Increase industry-supported R&D** at West Virginia's universities and colleges to match the national average by 2020
- **Increase the number of technology-based companies** in West Virginia at a rate higher than the national average
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach the national average by 2020
- **Increase the number of spin-off companies** developed from technology created at West Virginia's universities to achieve the national average by 2020

***Action E2.5: Implement advanced energy initiatives throughout governmental, government-related, industrial, and private sector sites to promote energy conservation and efficiency or deploy more environmentally friendly technologies***

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If the state and its private and public entities are to be leaders in advanced energy, they **must take a lead role in implementing new energy technologies**. Often, governmental involvement is required to employ progressive and innovative technologies, especially when those technologies can significantly impact the nation's security and future.

The goal of this action is to **create demand for advanced energy applications and technologies** to spur further demand and economic development in this sector.

Initiatives under this action may be simple and relatively inexpensive, such as providing tax credits or funding for specific technology applications, or more involved, such as installing new technologies in state-owned facilities.

However, **the State of West Virginia would not be required to immediately spend a lot of money**, but instead should integrate energy efficiency and environmentally friendly applications and technologies as new opportunities become available — and **only when the technologies add value and/or save money in the long term** (i.e., show a true return on investment). These opportunities could arise from upgrades of existing state facilities, including schools, government agencies, universities, etc., but also for construction of new facilities. The state may also consider providing incentives to private institutions in West Virginia to adopt West Virginia-generated energy technologies.

**Resources Required:** Could be significant, requiring state policy supports and financial incentives, but with value established, could far outweigh expenditures

**Priority:** High

**Time Frame:** Mid-term

**Recommended Lead Organizations:** Advanced Energy Platform Steering Committee, WVDO, West Virginia Division of Energy)

**Intended Outcomes:**

- **Increase industry-supported R&D** at West Virginia's universities and colleges to match the national average by 2020

- **Increase the number of technology-based companies** in West Virginia at a rate higher than the national average
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach the national average by 2020

### ***Action E2.6: Increase West Virginia's non-fossil fuel and energy portfolio***

This action is in line with several others described above (E1.2, E1.3, E2.1, E2.2, and E2.4) and is **aligned to previously described energy research and technology goals** (State of West Virginia, WVU, NETL, and MATRIC). However, it is included here for emphasis, as the significance of advanced energy projects for alternative energy sources like wind and solar will become increasingly important in future years.

To become and remain a leader in advanced energy, **West Virginia must be a major participant in the alternative energy area** in the future.

**Resources Required:** Initial support may be provided by Advanced Energy Platform Steering Committee members and related organizations

**Priority:** High

**Time Frame:** Mid-term

**Recommended Lead Organizations:** Advanced Energy Platform Steering Committee WVDO, and West Virginia Division of Energy)

**Intended Outcomes:**

- Continue to **grow the West Virginia academic R&D base** at a pace that significantly exceeds that of the nation, with a target of \$360 million by 2015
- **Increase R&D funding in platform areas** in all sectors (academia, nonprofits, and industry)
- **Increase industry-supported R&D** at West Virginia's universities and colleges to match the national average by 2020
- **Increase the number of technology-based companies** in West Virginia at a rate higher than the national average
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach the national average by 2020

	<p>ENERGY STRATEGY <b>THREE</b></p>	<p>Facilitate university, national lab, and non-profit engagement with industry for technology development and commercialization</p>
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**Rationale:** R&D innovations come to the market along two principal pathways:

- Technology-Push
- Market-Pull

Ideally, both pathways are at work in an economy. However, it is **typically more cost effective for innovations to occur through market-pull**. Over the past decade or more, industry research has increasingly focused on market needs for that reason. Likewise, industry has increasingly limited its basic research.

However, **basic research is also vital**, not only for the scientific discoveries that result, but also for significant, often step-change innovations that occur from more open-ended, fundamental investigations.

It has always been important for governments and foundations to provide funds for fundamental research; but, it has become even more critical for states and nations to support basic research in light of industry's reduction in that area.

Still, Battelle Technology Partnership Practice has found many regions of the nation with very limited activity along the market-pull pathway. In such regions, university or other research labs typically are being financed in a dominant way by federal research funds, justifiably responding to basic or even applied research issues and questions, but without the input of industry or the marketplace to drive findings to commercial viability.

This technology-push pathway is a valuable route, providing many fundamental scientific discoveries and applied technologies over the years, many that are the basis for new marketable technologies. However, **successful technology-based economic development usually occurs more readily from market-pull initiatives**. Industry simply knows its challenges, opportunities, and the needs of the marketplace and is well positioned to engage R&D institutions in applied projects to meet those challenges, opportunities, and needs.

In fact, recognizing the value of market-pull research, **major funding agencies have promoted industry-academia collaborations**. For example, the National Science Foundation (NSF) is a major funder of collaborative research centers. Likewise, the National Institutes of Health (NIH) is now heavily emphasizing translational research initiatives, hoping to accelerate the path of innovation to market.

Almost all research benefits from industry collaboration and interaction; but, this is even more true for the energy sector, especially for the big issues and opportunities surrounding the Advanced Energy and Energy-Related Technology platform. The **Advanced Energy Platform will greatly benefit from proactive industry engagement, cooperation, and collaboration**. It is Battelle's experience that when such cooperation occurs — when representatives of industry present their needs and challenges to teams of university researchers, for example, or industry-university teams work on problems together — the discovery and implementation of solutions rapidly accelerate.

***Action E3.1: Hold a series of forums/events in which energy-sector industry representatives outline their needs to the university, national lab, and nonprofit research leaders***

***This is an extremely important action and likely to produce rapid results.***

It is **recommended that this be done very soon — and before Action E1.3** to jump-start or at least support that action.

**Commercializing Technology:  
Technology-Push and Market-Pull**

**TECHNOLOGY-PUSH**

- **Technology pushed from R&D labs** by technology opportunities
- **No market need pre-identified** — Researchers make a discovery and then seek a market
- Often results from **basic research**

**MARKET-PULL**

- **Technology pulled from R&D labs** by market need
- **Market is pre-identified** — Industry identifies a market need and researchers produce an innovation to meet that need
- Often results from **applications-oriented, product-based, or process-based research**

It is **also recommended** that, if possible, this be done **after creating a university-industry matching grant program** (Action Eight in the General Report) to create an additional, concrete pull for university-industry interactions at this forum.

The concept is simple: bring university researchers and national lab researchers to a full-day event and have industry representatives outline their technological challenges, thoughts on new products, and market needs and opportunities.

**Battelle recommends that two events be planned**, the first focused on researchers listening to the needs of industry. A second event could be more liberal, allowing researchers to present their work on technologies and receive industry feedback and input in relation to application of these technologies or innovations.

**Resources Required:** \$10,000 for event development and planning and for conference hosting

**Priority:** High

**Time Frame:** Short-term

**Recommended Lead Organization:** Advanced Energy Platform Steering Committee

**Intended Outcomes:**

- **Increase R&D funding in platform areas** in all sectors (academia, nonprofits, and industry)
- **Increase industry-supported R&D** at West Virginia's universities and colleges to match the national average by 2020
- **Increase the number of technology-based companies** in West Virginia at a rate higher than the national average
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach the national average by 2020
- **Increase the number of spin-off companies** developed from technology created at West Virginia's universities to achieve the national average by 2020

***Action E3.2: Seek establishment of a nationally recognized (such as NSF) industry-university collaborative center in advanced energy technologies to be located at WVU and to focus on commercialization***

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*This action would also significantly support Energy Strategy Two (Establish West Virginia as a leader in advanced energy).*

A nationally recognized center focused on industry-university collaborations would provide West Virginia with **multiple and significant opportunities** to enhance the innovation economy in the state. With a focus on commercialization, it would offer potential for the development of new products and processes as well as the creation of start-up energy companies. It would also draw talented researchers and other professionals to the state.

The **NSF Industry/University Cooperative Research Centers (I/UCRCs)** program is a **good model** to consider and pursue for this action.

Despite the intensity of university and national lab R&D in West Virginia and the concentration of for-profit energy operations, there is no I/UCRC for energy or energy-related technologies in the state.

**West Virginia has one currently active I/UCRC**, the Center for Identification Technology Research (**CITeR**) serving the biometrics industry and discussed in the Identification, Security, and Sensing Platform (Biometrics) Report. However, as noted in focus groups for that platform, there is some concern about using an I/UCRC. CITeR, although very successful in many aspects, has generated concern in terms of working with industry and

commercializing technology. The Biometrics Working Group cited the following two concerns about CITEr, both of which would need to be considered in the development of an energy I/UCRC:

- **Industry is too often brought to the “biometrics table” through CITEr**, which takes work out of West Virginia (CITEr includes out-of-state universities)
- **Industry often does not want to work through CITEr** since intellectual property generated within an I/UCRC is not protected and instead remains in the public domain.

Still, an I/UCRC could provide a solid foundation for both fundamental research and technology development with commercial potential. This could form a component of the overall Institute program discussed in the General Report as well (Strategy Two, Action Seven).

**An alternative approach** would be to use the **existing NRCCE** at WVU as the focus for industry-university collaborative partnerships. While the NRCCE is not an NSF Center, it is a major information clearinghouse and research provider serving the energy and environment sectors. The NRCCE already has a substantial research operation and budget and could simply seek to significantly expand engagement with industry.

**Resources Required:** Volunteer time in evaluating if an NSF Center designation would enhance industry collaboration with R&D institutions in WV. Evaluation of NRCCE as collaborative industry-university center. An I/UCRC typically begins with a small NSF planning grant

**Priority:** High

**Time Frame:** Short- to mid-term

**Recommended Lead Organization(s):** Advanced Energy Platform Steering Committee and WVU (possibly NRCCE)

**Intended Outcomes:**

- Continue to **grow the West Virginia academic R&D base** at a pace that significantly exceeds that of the nation, with a target of \$360 million by 2015
- **Increase R&D funding in platform areas** in all sectors (academia, nonprofits, and industry)
- **Increase industry-supported R&D** at West Virginia’s universities and colleges to match the national average by 2020
- **Increase the number of technology-based companies** in West Virginia at a rate higher than the national average
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach the national average by 2020
- **Increase the number of spin-off companies** developed from technology created at West Virginia’s universities to achieve the national average by 2020

### ***Action E3.3: Encourage commercialization of intellectual property from the National Energy Technology Laboratory***

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*This directly links to the General Report (Strategy One, Action Four: Create a university-industry matching grant program) and is in fact the same action.*

Nothing encourages collaborations quite like the promise of money. **Many states (28) have put in place matching grant programs** designed to encourage industry-university collaborations. In some cases, university systems themselves have matching grant programs with industry (e.g., the University of California system). Typically, state-funded matching grant programs require at least a 1:1 match of state to private sector or industry funding.

The DOE also operates an industry-matching grants program in which universities can be recipients.

The **state should consider establishing a matching-grants program directed specifically at the technology platforms**. Thus, the state would initially fund two matching-grants programs — one focused on energy and the other on biometrics. Alternatively, the state may form a general matching-grants program available for work in any technology.

**Resources Required:** It is proposed that this program be initiated with \$250,000 in annual funding (for the Advanced Energy program only, but \$500,000 for the two platforms)

**Priority:** Medium

**Time Frame:** Mid-term

**Recommended Lead Organizations:** West Virginia Higher Education Policy Commission and WVDO (with support from Advanced Energy Platform Steering Committee)

**Intended Outcomes:**

- **Increase R&D funding** in platform areas in all sectors (academia, nonprofits, and industry)
- **Increase industry-supported R&D** at West Virginia's universities and colleges to match the national average by 2020
- **Increase the number of technology-based companies** in West Virginia at a rate higher than the national average
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach the national average by 2020
- **Increase the number of spin-off companies** developed from technology created at West Virginia's universities to achieve the national average by 2020

## CONCLUSION

**The State of West Virginia** — including governmental agencies, economic development groups, universities, nonprofit organizations, and business and industry — **must act boldly and quickly** to grow its research, technology transfer, and commercialization activities. TBED is an economic imperative, with multiple studies showing that a state's economic success can be largely attributed to the growth of high-technology businesses.

Innovation and technology lead not only to more jobs but also to higher-paying jobs, fueling economic growth and increasing the standard of living across entire states and regions where TBED is prevalent. Thus, **TBED is a critical component of West Virginia's economic future.**

Unfortunately, TBED is not widespread in West Virginia compared with other states. Its innovation economy is young and must be cultivated. West Virginia is behind its neighbors, behind its peers, and **behind most of the nation** in building a technology economy.

However, **West Virginia does have significant strengths** with strong foundations in several technologies, including in Advanced Energy and Energy-Related Technology.

This Blueprint lays out **recommended strategies and actions for the Advanced Energy Platform** — which can be used exactly as proposed or as guidelines for further refinement and development — **to boost West Virginia's energy technology economy.**

Successful implementation of the Blueprint will require:

- **Significant investments** in West Virginia's technology infrastructure
- **Strong leadership** from the recommended lead organizations — and other groups within the state
- **Long-term commitment** from all stakeholders, including West Virginia's citizens
- **Strong resolve** to make critical and sometimes difficult decisions
- **Genuine will to compete.**

No single organization will be able to carry out this Blueprint or boost West Virginia's innovation economy alone. But, with the right investment, true collaboration among all stakeholders in the state's public and private sectors, **West Virginia can and will become a leader** in this vital economic sector.

"We have a local saying that biotechnology in North Carolina has been a 30-year overnight success."

Barry Teater, North Carolina Biotechnology Center, in *Research Ripple: States attracted to job multiplier effect of biotech firms*, The Council of State Governments, May 2006.

This report and all other related reports — as well as  
other information about West Virginia's  
technology economy — can be found at...

**[www.TechConnectWV.com](http://www.TechConnectWV.com)**



*This report is the **ADVANCED ENERGY REPORT** only.*

The full reports can be found at:

[www.TechConnectWV.com](http://www.TechConnectWV.com)

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