WEST VIRGINIA BLUEPRINT FOR

TECHNOLOGY-BASED ECONOMIC DEVELOPMENT

CHEMICALS and ADVANCED MATERIALS

August 2011

TechConnect WEST VIRGINIA

Battelle *The Business of Innovation*

Chemical Alliance ZONE West Virginia

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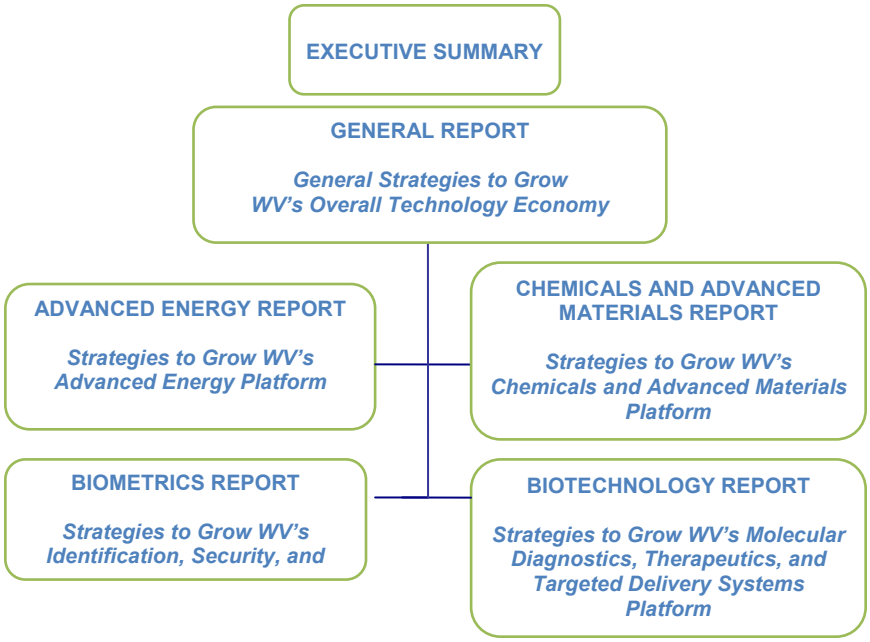
HOW THIS REPORT IS ORGANIZED

This report represents a component of Phase II of West Virginia's Technology-Based Economic Development (WV TBED) Blueprint. In 2007, Battelle Technology Partnership Practice produced the Phase I report entitled *Gap Analysis and Identification of Strategic Technology Platforms.* This was followed by an overall strategy to grow West Virginia's technology based economy along with two technology platform-specific reports the Advanced Energy platform and the Biometrics platform that released in March 2009.

In 2010, TechConnectWV worked with Battelle to complete reports for the remaining two platforms: Chemicals and Advanced Materials and Biotechnology. This report details findings and conclusions for the Advanced Materials and Chemicals platform.

Thus the West Virginia TBED Blueprint is organized into six distinct reports:



- **Executive Summary** – Provides a synopsis of introductory and background material and general strategies and actions for growing West Virginia's technology economy
- **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
- **Chemicals and Advanced Materials Report** – Provides detailed information on the specific strategies and actions for growing West Virginia's Chemicals and Advanced Materials 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.

Also, Battelle recently completed a **report for the new West Virginia Regional Technology Park**, and the recommendations made in that report either coincide with or are identical to the recommendations made in this report.

*This report is the **Chemicals & Advanced Materials Report** only*

This report and all other reports can be found at:
www.TechConnectWV.com

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 2008 and 2009, R&D at West Virginia's universities and colleges increased by 21% while total U.S. academic R&D increased by 5.8%*
    - *Between 2002 and 2009, R&D at West Virginia's universities and colleges increased an average of 11.4% per year while total U.S. academic R&D increased an average of 7.3% per year*
    - *The $360 million target represents an increase of just over 10% per year, roughly equivalent to the average from 2002 to 2009*
    - *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*
        - *2008: $170,869,000*
        - *2009: $174,486,000*
    - *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 2009, 2.9% 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 2009, an average of 3.3% of total R&D expenditures at West Virginia colleges and universities came from industry, compared with 5.4% 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 2008, 8.5% of West Virginia's total employment was in the high-tech *sector, compared with the national average of 11.4%*
    - 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 (2008) 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*

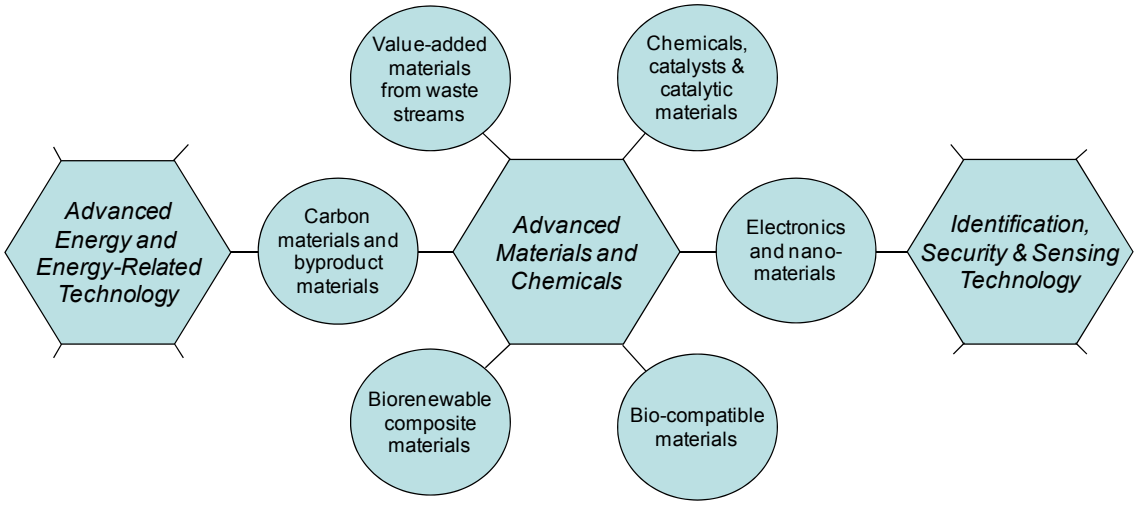
Technology Platform Strategies and Actions for Boosting Technology-Based Economic Development in West Virginia

Overview of the Chemicals and Advanced Materials Technology (CAM) Platform

The Chemicals and Advanced Materials Technology (CAM) platform focuses on multiple opportunities in research and development (R&D) and technology development applications related to **both traditional and innovative chemicals and materials technologies**. Chief among the goals of the platform should be to increase value-added economic activity based on chemicals and materials resources, including: (1) high-value materials from carbon-based chemicals and products, (2) alternative energy and fuels, (3) aerospace, energy, and high-temperature applications, (4) environmental mitigation products, and (5) advanced technologies for high-value-added specialty products.

Figure CAM-1 and the following descriptions illustrate the **areas of R&D-driven technology development opportunities envisioned** under the platform (from the Phase I study).

Figure CAM-1. Opportunities of the Chemicals and Advanced Materials Technology Platform



Opportunity 1: Carbon-Based Materials and By-Products – Technology for the conversion of fossil resources into value-added carbon products, chemicals, liquid fuels, and gases

Opportunity 2: Value-Added Materials from Waste Streams – Technology that uses high-volume inputs such as wood waste and converts them into advanced materials

Opportunity 3: Chemicals, Catalysts, and Catalytic Materials – Chemical technology that creates versatile compounds such as polyglycolic acid coatings or reduces emissions

Opportunity 4: Electronics and Nano-Materials – Development of materials that have micro-electronics applications and/or high-strength, flexibility, and temperature-resistant characteristics for use in drilling, energy generation, aerospace, or other applications

Opportunity 5: Composite Materials – Materials that are engineered from naturally occurring materials or formed from two or more constituent materials that, in the end product, have significantly different physical or chemical properties

Opportunity 6: Special Metals and Polymers – Alloys and polymers engineered to have superior performance characteristics in specific applications

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**. In fact, a relative new and very significant opportunity is briefly described in the box at right.

Marcellus Shale Ethane:
New Opportunity for WV's Chemical Industry

- Marcellus Shale gas fields stretching from NY to WV contain **vast amounts of natural gas**
- Marcellus gas contains **large amounts of ethane** that must be removed from natural gas
- Ethane is a **major chemical feedstock** and is used to produce ethylene, one of the two main building blocks for the petrochemical industry
- Use of Marcellus ethane for new and existing facilities could **revitalize and transform WV's and the region's chemical industry**

Chemicals and Advanced Materials Technology was selected as one of WV's four platforms (or strength areas) for several reasons:

Reason 1: The presence of a significant number of nonprofit and federal research institutions concentrating in materials science and chemical engineering. West Virginia University (WVU), Marshall University (MU), and the National Energy Technology Laboratory (NETL) produce an expanding body of intellectual property that enhances the state's CAM cluster opportunities.

Reason 2: The Battelle Phase 1 cluster analysis of West Virginia industry indicates strong competencies in chemicals and polymer technology. The Biotechnology, Advanced Energy, Biometrics and Nano-Technology, and Chemicals and Advanced Materials platforms all have a notable presence in West Virginia and also have potential interrelationships based on many common factors such as research, natural resources, and industrial production characteristics. The chemical industry has been traditionally strong in WV.

Reason 3: Core competency strengths include a robust variety of materials including electronic materials, composites, catalysts, carbon products, and bio-compatible products.

Reason 4: **Advanced applications for common West Virginia materials** and by-products are a significant focus for development in West Virginia's R&D institutions.

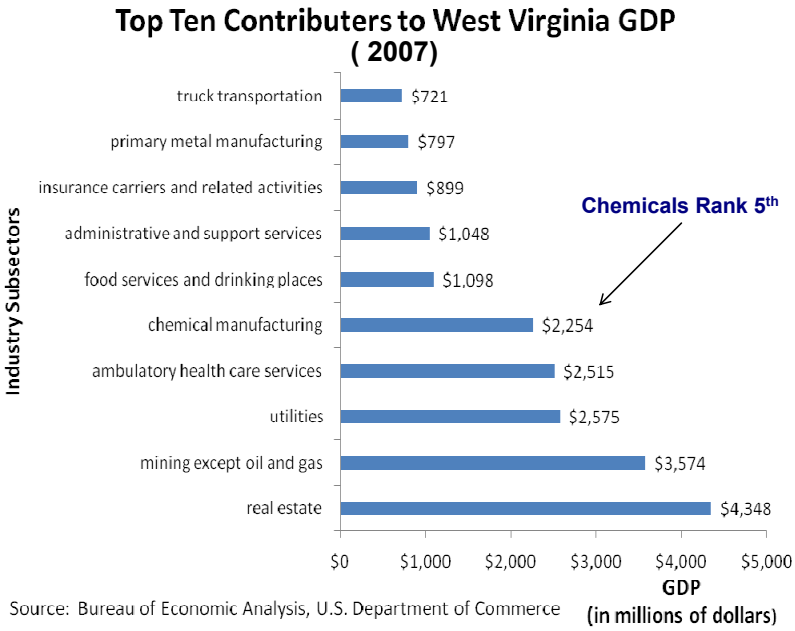
Reason 5: **West Virginia's large-scale fossil-fuel resource industry is threatened** by concerns over carbon dioxide emissions and global climate change, so the development of new uses for carbon resources and new technology to mitigate emissions is critically important to the state's economic base.

Industry Overview

The CAM cluster group is comprised of a diverse set of materials — including, for example, engineered wood products, specialized secondary metals and alloys, polymers, specialty chemicals, and other specialty materials. There are **109 companies** working in these sectors employing **10,531 West Virginia workers** at an average annual wage of **$70,000**.[i]

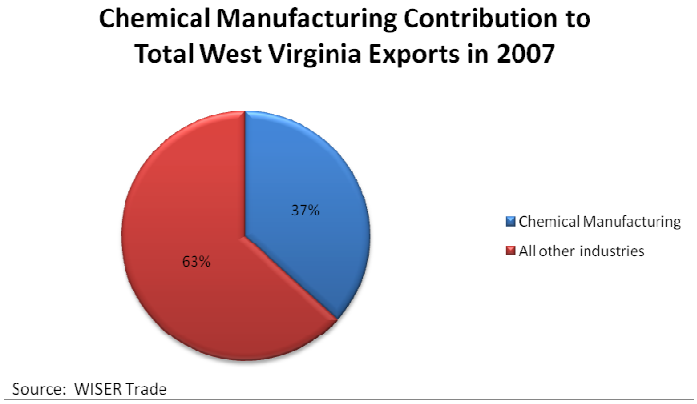
West Virginia's Chemical Industry (2007)

- ✓ Represents **1% of total US chemical industry**
- ✓ Represents **4% of WV's total GDP**
- ✓ Represents **35% of total WV manufacturing GDP**



Source: Bureau of Economic Analysis, U.S. Department of Commerce

Despite the recent recession, causing job declines in nearly every industry sector across the nation, the chemicals and advanced specialty materials cluster in West Virginia held on to its employee base better than the cluster did nationwide, declining, but at a slower rate than the sectors in the cluster group did nationally.



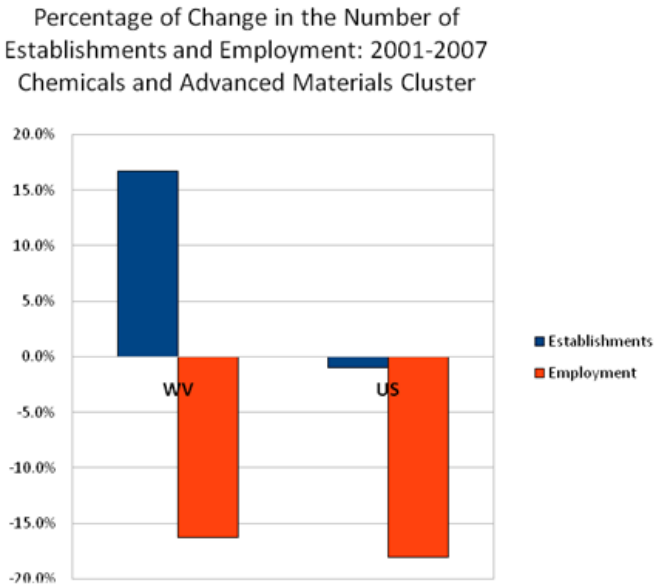
Source: WISER Trade

The World Institute for Strategic Economic Research (WISER)

Specialty chemicals is the largest sector by employment in West Virginia's Chemicals and Advanced Materials sector, followed by polymers, metals and alloys, engineered wood products, and specialty materials. Employment growth in the cluster group overall from 2001 to 2007 declined 16.3% in West Virginia, as opposed to a decline in employment in the cluster group by 18.1% nationally during the same period. There was moreover an increase in the number of establishments in the cluster group in West Virginia of 16.7%, compared to a 1% decline in the number of establishments nationally. This can partially be attributed to the formation of over 12 new companies that are commercializing new intellectual property at the South Charleston Tech Park after Union Carbide/Dow Chemical's closing of the research facility. West Virginia's efforts to retain leading researchers and the product development capacity at the Tech Park are sustaining the viability of the specialty chemicals and polymers sectors in the cluster group.

Stakeholder Input

In the Phase I gap analysis Battelle used its Core Competency Analysis to identify the CAM cluster group as a key technology platform for WV based on the state's R&D and industry strengths and market projections. For Phase II, interviews of the cluster's leaders in industry, R&D, academia, and government were held to gather more detailed information about the cluster group's companies, markets, assets, opportunities, and needs. Focus groups were also held with cluster leaders. The following assets, needs, challenges, and opportunities were identified in those interviews and focus group sessions.



Assets

West Virginia has a large base of specialty chemical companies, many of which have specialized facilities and infrastructure that could be accessed. The chemicals sector has many large company facilities that have been in place for decades and have been modernized. Several of these have been converted into industrial parks where new investments from other companies are welcomed. For example, Kureha PGA has installed a new $100 million facility on an unused section of the DuPont Belle site, taking advantage of the existing site infrastructure and on-site DuPont-produced glycolic acid to manufacture a high value-added specialty chemical, polyglycolic acid. West Virginia is home to 136 chemical plants including six headquarters, 95 branch plants, and 35 single location facilities. Bayer Materials Science, Bayer Crop Science, Dow Chemical, PPG, and FMC all have operations in West Virginia.

Major Chemical Companies in WV

DuPont – The miracles of science™

Bayer

Dow

PPG

Some of the companies started by MATRIC

- PolyPlexx, LLC
- Liberty Hydrologic Systems, LLC
- NG Innovations, Inc.
- SGA Polymers, LLC
- Aither Chemicals, LLC
- CxNanoPhysics, LLC
- TRAX BioDiscovery, LLC
- Certus Scientific, LLC

West Virginia's metals and alloys industry sector is globally competitive, producing high value-added materials and positioned to play an important role in the state's CAM cluster. West Virginia Alloys and Special Metals, for example, produces high-performance tubing for aerospace and energy applications. Alliance Technology (ATK) produces carbon fiber for centrifuge tubing at its Rocket Center, West Virginia plant. Touchstone Research Laboratory in Triadelphia makes several advanced materials, including CFOAM,® a structural material made from coal, and MetPreg,™ a fiber-reinforced aluminum material. These represent West Virginia operations competing on the global business stage by producing high-value added materials.

West Virginia's Mid Atlantic Research Technology and Innovation Center (MATRIC) is leveraging the expertise of ex-Dow employees to create new companies and launch new products. MATRIC is a non-profit corporation with three for-profit subsidiaries. MATRIC has started 12 new companies in the six years of its existence. MATRIC stands as an impressive example of skilled human capital, in combination with legacy industry assets and infrastructure, being leveraged in new company formation.

The West Virginia Regional Technology Park represents a signature asset for the CAM cluster to leverage moving forward. The West Virginia Higher Education Policy Commission, a state agency that oversees higher education in WV, including research, is the new owner of the former Union Carbide/Dow Tech Park in South Charleston, first preliminarily named the West Virginia Education, Research and Technology Park and later named the WV Regional Technology Park (WVRTP or Tech Park). The Tech Park contains significant assets directly relevant to the CAM Cluster, including multiple pilot production plants and laboratory buildings.

Chemical Alliance Zone (CAZ)

Chemical Alliance ZONE West Virginia

Supporting and Growing WV's Economy through the Business of Chemistry

- ✓ Three main activities:
  - **Attract** Chemical Companies
  - **Promote and Support** the Chemical Industry
  - **Boost** WV's Tech-Based Economy
- ✓ Key Accomplishments
  - Formation of the **WV Regional Technology Park**
  - Attraction of **Kureha** to DuPont Belle Site
  - Formation of the **Chemical Operator Training Program**
- ✓ Key Current Project – Attracting major investment to use vast **Marcellus Shale ethane** resources in WV

Industry leaders interviewed conveyed that there is a full range of service companies in the region with experience serving chemicals and materials companies. Thus, the supply, construction, maintenance, testing, engineering, and logistical needs of the plants in the state are said to be well-served.

Economic development leaders and stakeholders maintained that West Virginia is well-equipped with an array of technology-development supporting organizations and programs. Specific to the cluster, the Chemical Alliance Zone and the Polymer Alliance Zone support technology-development efforts in the chemical and polymer industries. The West Virginia Development Office, the West Virginia Job Investment Trust, and INNOVA provide financial or technical assistance to start-up technology companies. Participants in Battelle's interviews and groups sessions were clear, however, that more financial resources are needed for West Virginia's technology-based economic development (TBED) efforts to have a truly significant impact.

There are large and well-funded research institutions in West Virginia, which have expertise in areas of importance to the CAM industry. These include the U.S. Department of Energy's National Energy Technology Laboratory (NETL) — which concentrates a significant component of its $35 million annual research budget on fossil fuel energy and efficiency and innovations in coal processing chemistry — and WVU and MU which are producing innovations and technologies with product potential in all five sectors of the CAM cluster. MU and WVU are also engaged with the private sector in commercializing the products of their research.

West Virginia has strong technical training institutions that can help train the future workforce for the CAM industry. These include Bridgemont Community and Technical College, Kanawha Valley Community and Technical College, West Virginia Institute of

Technology, and the Robert C. Byrd Institutes (together with the entire small college and community college system). These were recognized during Battelle's interviews and focus group sessions as valuable components of WV's technology workforce development system, not only for their educational component but also for their responsiveness to industry needs.

West Virginia has several additional advantages that support the case to intensify CAM TBED. The state's Eastern Seaboard location puts it in close proximity to major transportation routes and market centers. There is a well established production infrastructure in all five of the chemicals and advanced materials cluster sectors. The research in several R&D institutions in West Virginia has the capability to grow and provide a flow of innovation over time. West Virginia also has natural resources and an ample supply of raw materials for many of the emerging cluster products. Finally, the people of West Virginia factor in strongly as well. The workforce is known for its skills and adaptability to changes in West Virginia's industries, and the leaders of West Virginia are increasingly committed to TBED.

Polymer Alliance Zone (PAZ)

Polymer AllianceZone® of West Virginia

Marketing and Recruiting the Plastics Industry in WV

✓ Key Accomplishments:

- Development of the **Polymer Technology Park**
- Recruitment of **PWP Recycling** to the Polymer Technology Park
- Establishment of plastics-related **workforce training programs**
- Helped develop WV's plastic industry into **$2.2 billion industry**, 3.6 percent of gross state product.

✓ Key Current Project – Constructing 100,000 sq. ft. building in the Polymer Technology Park for warehousing and light manufacturing

Challenges

It was agreed by many in industry, R&D, academia, and the government that the components of a strong chemicals and advanced materials cluster are present in West Virginia but that **several concurrent initiatives, programs, agencies, and investor groups must be better coordinated** to better leverage the research products, facilities, and cluster companies in the state.

Company officials and workforce development experts expressed general satisfaction with the skilled workforce but cautioned that in the near future, **retirements of "Baby Boom" cohort workers will require more replacement workers than in prior years** due to the upcoming increased attrition rate. Several of those providing their input asserted that the government of West Virginia was committed to TBED but specialized staff with expertise in technology companies will be necessary.

wvchemicaljobs.com
CHEMICAL PROCESS OPERATOR TRAINING PROGRAM

The Chemical Allilance Zone, along with the WV Manufacturer's Association and the Community and Technical College System of WV have developed an **operator training program** for WV's chemical industry

A sense of frustration with the academic intellectual property commercialization process was virtually unanimous. There was also a sense that no one fully knew all of West Virginia's assets and opportunities relevant to this cluster. Industry leaders also were not fully aware of all the industry-applicable research discoveries being produced, where they were produced, and what companies might be able to assist in further developing or commercializing new discoveries. Many leaders also were unaware of pilot plants in West Virginia where new products could be developed and small-scale commercial or demonstration quantities could be made. Participants also related that technical and

financial assistance programs and contacts, useful in the commercialization process, were hard to find, and that one was essentially faced with having to piece the process together on his own.

Opportunities

TBED leaders pointed out several ***opportunities*** in the CAM cluster, including those below.

- **Baby Boom retirements** that are expected in the next decade, while potentially creating a shortage of workers from operating personnel to researchers, is actually an opportunity to retrain larger numbers of the workforce and train young people entering the workforce for emerging advanced and specialty materials cluster needs.

- **Orphaned technology** that state-based companies developed but did not put into production may be exploited.

- Several company officials related that there are more **energy applications** for their technologies, many related to the Chemicals and Materials cluster, both in drilling and extraction as well as in energy generation.

- **Composites produced in West Virginia have multiple markets**, including aerospace, energy, public works, construction, and mine safety. The products range from building panels and guard rail spacers made from high-volume waste streams to carbon-fiber reinforced ceramic-matrix airplane parts. Carbon products from coal range from traditional carbon rods to carbon fiber. These products have applications for both West Virginia and out-of-state manufacturers.

- **Several technologies are being developed to help solve critical water issues in the energy area.** For example, a biochemical environmental remediation process developed in West Virginia by Liberty Hydrologics, LLC is beginning to play an important role in the treatment of mining wastewater. Another technology is being developed with the assistance of an NSF grant by the West Virginia Institute of Technology. With Marcellus Shale water use concerns, chemical applications to water treatment are likely to represent a growth opportunity.

- **The Tech Park is an extremely promising opportunity** for developing West Virginia's advanced and specialty materials cluster. It has numerous facilities to house labs, business development services, and other related facilities, including 42 pilot plants. In addition, planned technical training facilities and programs will be provided by Bridgemont Community and Technical College and the Kanawha Valley Community and Technical College. A new Advanced Technical Training Center will also be built on the site. The park can accommodate many companies' administration, research, and pilot production needs. Co-location of all of these assets moreover provides opportunities for exchanging ideas for potential joint ventures.

- **Throughout West Virginia there are legacy installations, some of which have excess capacity or acreage to accommodate cooperative ventures** (as illustrated by the success of the Kureha PGA operation at the DuPont Belle Plant). Many of these facilities have been transformed from single-company manufacturing plants into many-company industrial parks.

Suggested Actions

Interview and focus group participants emphasized the ***need to make the following improvements*** to the West Virginia TBED system in order to grow the cluster base:

- **Create an inventory** of private and public assets, production facilities, research facilities, pilot plants, research products, industrial needs, market opportunities, technical assistance sources, financial assistance sources, investors and investor groups, and workforce resources. Some of this information will likely be exchanged through informal channels, such as through networking events and presentations.

- **Provide a clear process to commercialization**, especially to researchers. A clear pathway to commercialization that is as common as possible across technology platforms and jurisdictions in the state — similar to the US DOD's *Unmanned Systems Integrated Roadmap*, which provides a clear timetable and budget information for priority research needed by that Department — would make application and commercialization of new technologies much more efficient.

- **Better integrate the IP commercialization process with venture funding sources**. Faculty should be given more incentive for entrepreneurial and IP development activities, and universities should be more flexible in their equity demands

- **Reduce risk aversion** in the general public and with West Virginia's leadership. Investors and entrepreneurs do not see managed risk as a threat, but public perceptions are much less tolerant of risk in West Virginia and are a barrier to significant new business development, especially in the technology sector.

- **Standardize due diligence and entrepreneur qualification for capital**. Entrepreneurs have numerous demands. Due to start-up companies' small size and entrepreneurs' time limits, preparing several — and sometimes numerous — sets of due diligence reports prevents entrepreneurs and small businesses from obtaining adequate funding and thus getting their products into the market.

Strategies and Actions

Four strategies and 20 actions, summarized in Table CAM-1 and detailed below, are proposed to grow West Virginia's chemicals and advanced materials 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 actions should be undertaken in 1 to 3 years, and mid-term actions should be undertaken in 3 to 5 years.

Table CAM-1. Overview of Chemicals and Advanced Materials Strategies and Actions

Strategy One: Bring key stakeholders together to guide chemicals and advanced materials development in West Virginia	Strategy Two: Leverage assets to achieve industry recruitment and expansion in the cluster
Action CAM1.1 Use the existing Chemical Alliance Zone organization to be the lead organization on platform development and coordination, with the Polymer Alliance Zone and emerging WEST VIRGINIA Tech Park leadership working in collaboration with CAZ **Action CAM 1.2** Form under the CAZ appropriate technology or market specific subcommittees with focus on specialty chemicals, polymers, composite materials, advanced metals and alloys and other sub-sectors prioritized by the blueprint steering committee	**Action CAM2.1** Assemble an inventory and centralized web-based database of key companies, production capacities (from pilot through full-scale production) and R&D assets related to the platform in WEST VIRGINIA. **Action CAM2.2** Work with existing CAM industry within WEST VIRGINIA to identify supply-chain gaps and associated opportunities, and to identify ways to utilize/leverage excess capacity at existing WEST VIRGINIA facilities. **Action CAM2.3** Identify and market opportunities to leverage current feedstock and chemical or material precursor's production for the attraction of new value-added producers. **Action CAM2.4** Assist in marketing WEST VIRGINIA Tech Park piloting and scale-up assets and associated business facilities
Strategy Three: Enhance West Virginia's position in chemicals and advanced materials R&D and associated innovation-based business development	**Strategy Four: Assure West Virginia has a world-class workforce able to meet the current and future demands of the cluster**
Action CAM3.1 Enhance connectivity of West Virginia's CAM industry base to R&D assets, including West Virginia's research universities, the DOE NETL, MATRIC and others **Action CAM3.2** Establish a world-class chemical engineering research institute or initiative to deepen the capacity in West Virginia to be an innovation leader and to be a focal point for industry, university, and national lab collaborations **Action CAM3.3** Coordinate activities between the platform and TechConnectWV to ensure appropriate programs are in place to support the commercialization of CAM innovations and new technologies **Action CAM3.4** Develop a CAM Entrepreneurship Network comprising the universities, NETL, CAZ, MATRIC and other relevant parties to provide information, connections, and services in support of new CAM business ventures	**Action CAM4.1** Under the CAZ, form a working committee to focus on CAM-related workforce development and education **Action CAM4.2** Engage industry in collaborations with community and technical colleges to develop courses and curricula to meet the current and emerging workforce needs of the CAM sector **Action CAM4.3** Assist in coordinating Internship programs with West Virginia CAM industry for students enrolled in relevant science and engineering disciplines at West Virginia's universities, colleges, and community colleges

Table CAM-2: Chemicals and Advanced Materials Strategies and Actions: Priorities, Resource Requirements and Lead Organizations

Chemicals and Advanced Materials Strategy ONE	**Bring key stakeholders together to guide chemicals and advanced materials development in West Virginia**			
Action	**Priority**	**Timeframe**	**Lead Organization(s)**	**Resources**
Action CAM1.1 Use the existing Chemical Alliance Zone organization to be the lead organization on platform development and coordination, with the Polymer Alliance Zone and emerging West Virginia Tech Park leadership working in collaboration with CAZ	Critical	Immediate	Chemical Alliance Zone, with support of TechConnectWV, the Polymer Alliance Zone, West Virginia ERT leadership and WVDO	$250,000 annually
Action CAM 1.2 Form under the CAZ appropriate technology or market specific subcommittees with focus on specialty chemicals, polymers, composite materials, advanced metals and alloys, and other sub-sectors prioritized by the blueprint steering committee	High	Immediate	Chemical Alliance Zone and Polymer Alliance Zone	CAZ staff + $20,000 annual budget for meetings
Chemicals and Advanced Materials Strategy TWO	**Leverage assets to achieve industry recruitment and expansion in the cluster**			
Action	**Priority**	**Timeframe**	**Lead Organization(s)**	**Resources**
Action CAM2.1 Assemble an inventory and centralized web-based database of key companies, production capacities (from pilot through full-scale production) and R&D assets related to the platform in West Virginia.	High	Near-term	Chemical Alliance Zone and Polymer Alliance Zone	$200,000–$250,000 for staff time and contractor support. Seek grant from WVDO, EDA
Action CAM2.2 Work with existing CAM industry within West Virginia to identify supply-chain gaps and associated opportunities, and to identify ways to utilize/leverage excess capacity at existing West Virginia facilities.	High	Near-term	Chemical Alliance Zone and Polymer Alliance Zone	CAZ staff
Action CAM2.3 Identify and market opportunities to leverage current feedstock and chemical or material precursor's production for the attraction of new value-added producers.	High	Mid-term	Chemical Alliance Zone and Polymer Alliance Zone	CAZ staff
Action CAM2.4 Market WV Tech Park piloting and scale-up assets and associated business facilities	Critical	Near-term	WV Tech park and WVDO with support from CAZ and PAZ	WV Tech Park and WVDO staff

Chemicals and Advanced Materials Strategy THREE	Enhance West Virginia's position in chemicals and advanced materials R&D and associated innovation-based business development			
Action	**Priority**	**Timeframe**	**Lead Organization(s)**	**Resources**
Action CAM3.1 Enhance connectivity of West Virginia's CAM industry base to R&D assets, including West Virginia's research universities, the DOE NETL, MATRIC, and others	Medium	Mid-term	Chemical Alliance Zone, Polymer Alliance Zone, WVU, MU and NETL	CAZ staff with assistance of collaborating institutions. Establish matching grants program to encourage joint industry/institution R&D programs.
Action CAM3.2 Establish a world-class chemical engineering research institute or initiative to deepen the capacity in West Virginia to be an innovation leader and to be a focal point for industry, university, and national lab collaborations	Medium	Mid-term	WVHEPC, WVU MU and NETL	$300,000–$500,000 for planning. Bonding of $10 million for initial endowment, with $10 million annual commitment for 10 years
Action CAM3.3 Coordinate activities between the platform and TechConnectWV West Virginia to ensure appropriate programs are in place to support the commercialization of CAM innovations and new technologies	Medium	Mid-term	Chemical Alliance Zone and TechConnectWV	Existing resources
Chemicals and Advanced Materials Strategy FOUR	**Assure West Virginia has a world-class workforce able to meet the current and future**			
Action	**Priority**	**Timeframe**	**Lead Organization(s)**	**Resources**
Action CAM4.1 Under the CAZ, form a working committee specific to focus on CAM-related workforce development and education	High	Near-term	Chemical Alliance Zone and WVHEPC	Included in funding proposed for CAZ
Action CAM4.2 Engage industry in collaborations with community and technical colleges to develop courses and curricula to meet the current and emerging workforce needs of the CAM sector	High	Near-term	WVHEPC and Chemical Alliance Zone	$1 million in funding for establishing training programs and curriculum development
Action CAM4.3 Assist in coordinating Internship programs with West Virginia CAM industry for students enrolled in relevant science and engineering disciplines at West Virginia's universities, colleges, and community colleges	Medium	Mid-term	WVHEPC, WVU, MU and Chemical Alliance Zone	Included in funding proposed for CAZ

Chemicals and Advanced Materials Strategy ONE	**Bring key stakeholders together to guide chemicals and advanced materials development in West Virginia**

Strategy Rationale: Each technology platform blueprint must be led by a centralized entity. This group should coordinate resources, track progress, and convene key stakeholders. This concept has proven time and time again to be **critically important to the success of cluster-based TBED efforts**. TechConnectWV is taking the lead as the central coordinator for the overall TBED strategy in West Virginia with delegation to partner organizations for specific platforms. In the CAM platform, WV benefits from the operations of two existing organizations related to the platform — the Chemical Alliance Zone (CAZ) and the Polymer Alliance Zone (PAZ).

Because of the size of the chemicals sector, the likely focus of the Tech Park, and existing relationships with both TechConnectWV and the Tech Park, **Battelle recommends that the Chemical Alliance Zone takes the primary role in leading the CAM cluster** in close collaboration with the Polymer Alliance Zone. In fact, CAZ is a founding partner of TechConnectWV and is, like TechConnectWV, committed to boosting West Virginia's overall technology sector. CAZ also has an incubator at the Tech Park, the Biotechnology and Allied Sciences Incubation Center (BASIC) and has been closely involved with and committed to the redevelopment and revitalization of the Tech Park.

Specific action recommendations under Strategy One are as follows:

Action CAM1.1 - Use the existing Chemical Alliance Zone organization to be the lead organization on platform development and coordination, with the Polymer Alliance Zone and emerging WV Regional Technology Park leadership working in collaboration with CAZ

CAZ is an existing non-profit group committed to maintaining and expanding the presence of the chemical industry in West Virginia. The primary official geographic focus of the CAZ has been the counties of Cabell, Kanawha, Putnam and Wayne (a traditional geographic hub of chemicals manufacturing in the state), but that region has been officially expanded to include part of Marshall County as well. And CAZ works to boost WV's chemical industry and technology economy throughout the state. Still, the official geographic focus may need to be expanded to encompass the entire state for blueprint implementation.

> The Chemical Alliance Zone (CAZ) was created in 1999 to channel and leverage efforts to strengthen West Virginia's chemical industry. A nonprofit collaborative of citizens, labor leaders, educators, government officials, chemical executives and business leaders, the CAZ is dedicated to maintaining and expanding the business of chemistry throughout West Virginia.
>
> *Source: www.cazWest Virginia.com*

Because the CAM cluster encompasses more than just chemicals, CAZ should work with other groups, especially PAZ. Similar to the CAZ, the PAZ is a non-profit, member-led organization focused on developing the polymers sector in Jackson, Mason, and Wood counties.

As the platform organizer, CAZ will be responsible for overall blueprint implementation and tracking, for bringing key stakeholders together as a platform steering committee, and for working in close collaboration with TechConnectWV and the state on policies and programs designed to enhance TBED development in the state in the CAM cluster.

Resources Required: $250,000 annually for operational budget for CAZ activities in facilitation and management of the platform

Priority: Critical

Time Frame: Immediate

Recommended Lead Organization: Chemical Alliance Zone

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 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 CAM 1.2 - Form under the CAZ appropriate technology or market specific subcommittees with focus on specialty chemicals, polymers, composite materials, advanced metals and alloys and other sub-sectors prioritized by the blueprint steering committee

These subcommittees will need to include people working in specific policy, administrative, financial, technical, production, marketing, and other areas of the CAM platform. These subcommittees will coordinate and implement specific actions charged to each group.

Priority: High

Time Frame: Immediate

Recommended Lead Organization: Chemical Alliance Zone

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 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

Chemicals and Advanced Materials Strategy TWO	**Leverage assets to achieve industry recruitment and expansion in the cluster**

Strategy Rationale: West Virginia benefits from a range of infrastructure, industry, workforce and R&D assets that enhance the attractiveness of the state as a location for industry in the chemicals and advanced materials sectors.

Key assets to leverage include:

- **Existing CAM Products** that can be used as feedstocks to manufacture value-added chemicals and materials
- **Existing Manufacturing Operations** with excess capacity or expansion capabilities to facilitate joint ventures or other business development
- **Existing Industrial Parks,** including several owned and operated by major chemical companies and others owned and operated by economic development organizations (including PAZ's Polymer Technology Park)
- **The WV Regional Technology Park** — a proven location for chemicals and materials R&D and company operations with a unique suite of R&D space, commercial development and small-manufacturing plant facilities, and an on-site base of industry expertise and resources

Co-Location Opportunities at Existing Chemical Industry Sites (Industrial Parks) in WV

- ✓ Bayer CropScience, Institute
- ✓ Bayer MaterialScience, New Martinsville
- ✓ Dow Chemical, South Charleston
- ✓ DuPont, Belle
- ✓ PPG, New Martinsville

Few places within the United States have an emphasis on the attraction and development of the CAM sector. WV can differentiate itself with this industry by placing an increased and concerted effort on regional promotion and investment attraction based on a sound foundation of assets and positive characteristics.

Specific action recommendations under Strategy Two are as follows:

Action CAM2.1 - Assemble an inventory and centralized web-based database of key companies, production capacities (from pilot through full-scale production) and R&D assets related to the platform in West Virginia

This task includes the assembly of existing inventories of companies, ownership, research products, IP, ongoing research, facilities, funding programs, relevant quantitative trends, investments, workforce characteristics, etc., and new data into a single vehicle to facilitate more effective collaboration and partnering among cluster stakeholders. This database will need to be developed in a form that is easily updated, verified, secured as necessary, and accessed.

Priority: High

Time Frame: Immediate

Recommended Lead Organization: Chemical Alliance Zone

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 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 CAM2.2 - Work with existing CAM industry within West Virginia to identify supply-chain gaps and associated opportunities, and to identify ways to utilize/leverage excess capacity at existing West Virginia facilities

The CAZ and PAZ are in the position to identify opportunities for the use of existing industrial plants' excess capacity for joint ventures or leasing opportunities. In fact, PAZ and CAZ already participate in these types of activities. Many potential ventures are in the Kanawha and Ohio Valleys where legacy infrastructure could be used for new CAM manufacturing facilities. In addition, existing products could be used as feedstocks to make higher-value chemicals and materials. The Kureha PGA venture on DuPont's Belle plant, which CAZ was heavily involved in, demonstrates this activity.

Priority: High

Time Frame: Immediate

Recommended Lead Organization: Chemical Alliance Zone

Intended Outcomes:

- **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 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 CAM2.3 - Identify and market opportunities to leverage current feedstock and chemical or material precursor's production for the attraction of new value-added producers.

This task will be assisted greatly by the inventory developed in Action CAM 2.1. Company representatives throughout the cluster were not aware of products being manufactured within the state. This is not unique to the CAM cluster or to WV, but better knowledge of industry products in the state and the subsequent marketing of those products to value-added producers will give West Virginia a competitive advantage.

Priority: High

Time Frame: Immediate

Recommended Lead Organization: Chemical Alliance Zone

Intended Outcomes:

- **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 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 CAM2.4 - Marketing WV Tech Park piloting and scale-up assets and associated business facilities

The WV Regional Technology Park contains facilities that should be attractive to a number of different groups, from researchers and entrepreneurs to small technology companies to even large chemical, energy, and technology companies. This is an asset in itself and should become a targeted business development function for the state. However, the Tech Park can also bring value to other economic development opportunities, providing access to pilot production and scale-up facilities for CAM and emerging growth companies. The Tech Park also contains high quality, multi-tenant space for R&D of all types.

Battelle also recommends the following to maximize the opportunity provided by the Tech Park:

- **Creation of Various Types of Multitenant R&D and pilot facilities,** with appropriate collaborations among anchor tenants**.**
- **Provision of pilot plant equipment and working capital** to assist and recruit emerging out-of-state (and in-state) companies with processing needs. Battelle's interviews with prospective users indicated that simply having an experienced, expert operator may not be sufficient to lure these companies to the Tech Park. These financing programs could be contingent upon co-location of business operations in West Virginia or could be structured so the Tech Park takes an equity position in the business ventures.
- **Hiring a lead marketing staff person** responsible for pro-active outreach

marketing and recruitment. This person should also have an administrative assistant and a budget for travel, direct mail, attendance at selected trade shows, and earned media of $150,000 per year.

- **Creation of an innovation-based business environment** attuned to the needs of emerging energy, advanced materials and chemicals, and engineering and testing services companies. This should include access to professional and mentoring services, connections with higher education resources and expertise, and access to capital sources. To staff this function, a business services coordinator should be put in place and up to $50,000 of funding be made available for services.

Priority: Critical

Time Frame: Immediate

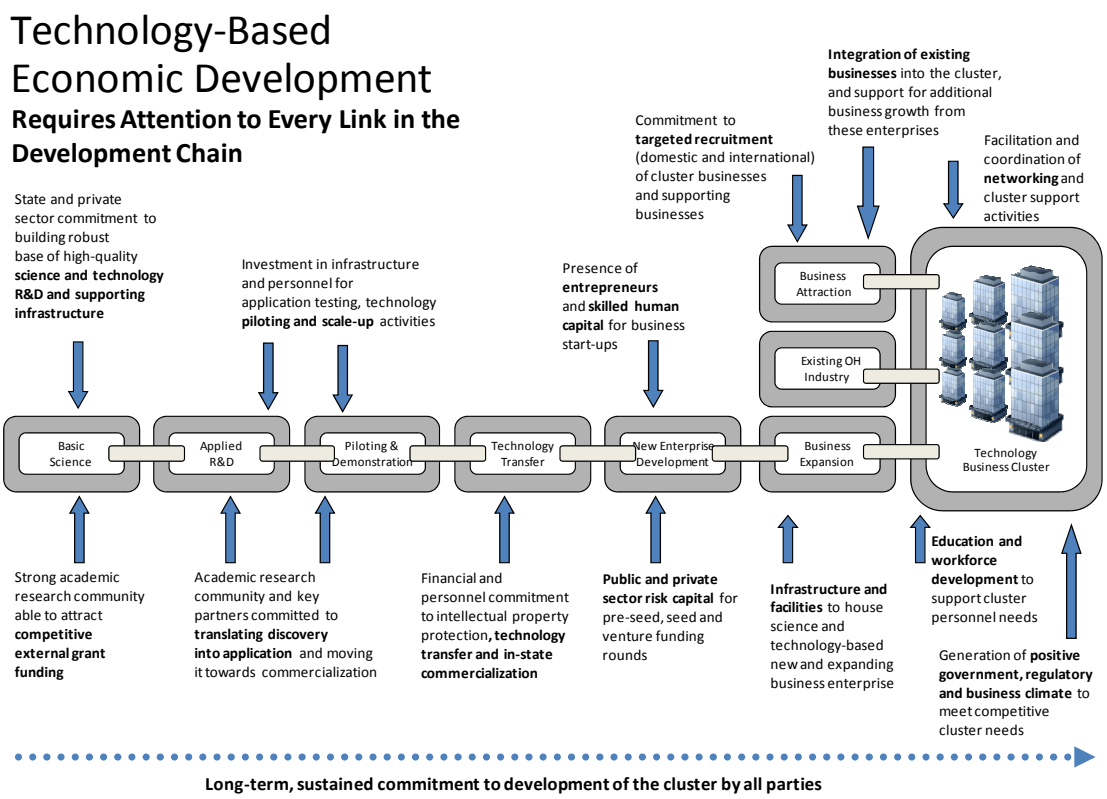
Recommended Lead Organization: WV Tech Park, WVDO with support from CAZ and PAZ

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 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

Chemicals and Advanced Materials Strategy THREE	**Enhance West Virginia's position in chemicals and advanced materials R&D and associated innovation-based business development**

Strategy Rationale: Recruiting industrial firms to locate in West Virginia will not be sufficient to build the state's CAM cluster. For a robust future, **West Virginia also needs to generate R&D-based innovation and spur formation of new technology businesses**. As the graphic below illustrates, successful technology development consists of a chain of activities, and some of the most critical links occur via R&D activities and the commercialization and implementation of new technologies emerging from R&D.



West Virginia has an extremely strong track record in chemicals and materials research and development. In fact, the former Union Carbide Technical Center in South Charleston was one of the world's foremost centers of innovation in the chemicals and plastics industry. This R&D excellence, while diminished in scale, is still present in MATRIC, West Virginia industry, and also within certain university R&D programs and centers. While the decline in R&D intensity from Union Carbide and Dow has certainly been felt, there is still a base of R&D innovation and assets to build upon. Reinvestment and concerted development activities are required to once again have R&D driving business and cluster development around chemicals and advanced materials in West Virginia.

Specific action recommendations under Strategy Three are as follows:

Action CAM3.1 - Enhance connectivity of West Virginia's CAM industry base to R&D assets, including West Virginia's research universities, the DOE NETL, MATRIC, and others

Intellectual property typically needs to be commercialized within four years to leverage and justify the research investment. The CAM Cluster Inventory, as well as regular interaction and collaboration among industry and West Virginia's universities and R&D institutions, will accelerate help ensure that new IP is brought to market in a timely fashion.

Priority: High

Time Frame: Immediate

Recommended Lead Organization: Chemical Alliance Zone

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 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 CAM3.2 - Establish a world-class chemical engineering research institute or initiative to deepen the capacity in West Virginia to be an innovation leader and to be a focal point for industry, university, and national lab collaborations

Despite the historical presence of chemical, materials and energy industries in West Virginia, with strong requirements for chemical engineering competencies, the university research base in West Virginia is not among the nation's leaders in chemical engineering. The National Energy Technology Laboratory clearly has many chemical engineering competencies, but its R&D funding is declining and much of it is directed to extramural activities at universities.

In the past, much of the chemical engineering R&D taking place in West Virginia was industry driven. But there has been a critical shift in industry thinking about internal R&D activities. As the National Academies of Science recent report updating *Rising Above the Gathering Storm* points out: "…the great United States corporate research laboratories of the past are increasingly becoming a thing of the past."[ii] And as Henry Chesbrough, a noted business professor who tracks R&D activities, has pointed out, internal R&D was once viewed as a strategic asset and a barrier to entry. Rivals had to use significant resources to create their own labs. Now, companies like Microsoft and Genentech conduct little or no basic research but still innovate using others' research discoveries."[iii]

West Virginia has been a victim of this shift away from relying on corporate internal R&D labs, as the state's take-over of the Dow/Union Carbide research center partly demonstrates. But this does not mean that R&D is any less important for advancing West Virginia's chemicals, materials and energy industries. It simply means that the state and its research universities must help in filling the void, or **West Virginia risks falling behind fast-moving competitors — both nations and other states** — which are making these investments in R&D.

It is proposed that West Virginia create and fund a center of research excellence in chemical engineering that connects the strengths of the state's universities and national labs to address significant challenges facing the chemicals, materials and energy industry in chemical process technologies. The starting point for this program activity should be a twelve-month planning study for a West Virginia Center of Excellence in Chemical Engineering (or an Institute or Initiative) to identify the focus, required facilities, partners, programs, and likely research leaders.
Among the key questions to be addressed in the planning study are:

- **What are the major technological challenges** facing the chemicals, materials and energy industries as informed by active outreach to industry chief technology officers?

- **What would be the design of a research center** to address these needs and position West Virginia for the next generation of innovative leadership in chemical process engineering and technology development?

- **Who are the likely research leaders and partner organizations** that West Virginia should work with?

However, for this planning effort to be taken seriously, a major endowment should be created at the West Virginia Higher Education Commission at the outset of the planning process to demonstrate the state's commitment to this effort. It is proposed that $300,000 to $500,000 be allocated for the planning study to be conducted by a top tier R&D consulting organization. Bonding of $10 million towards the initial endowment for this West Virginia Center of Excellence should be made with a commitment of $10 million annually for the next 10 years.

It is important to note that the Institute or Initiative recommended here is the **same Institute or Initiative recommended in Battelle's report for the WV Regional Technology Park**.

Priority: High

Time Frame: Immediate

Recommended Lead Organization: Chemical Alliance Zone

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 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

CAM3.3 - Coordinate activities between the platform and TechConnectWV to ensure appropriate programs are in place to support the commercialization of CAM innovations and new technologies

Researchers often need much assistance on their way from the lab to the marketplace, including help with business planning, entrepreneurial mentoring, product marketing, and seed and venture capital funding. TechConnectWV has a statewide viewpoint and a head start in developing the programs to close the technology commercialization gaps throughout West Virginia and help ensure that researchers and start-up companies move efficiently through each stage of development, from research to concept to product to new company.

Battelle recommends that TechConnectWV hold a series of special events in which CAM industry representatives outline their needs to the university, national lab, and nonprofit research leaders. In a full-day event, industry representatives would 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 and a second focused on researchers presenting their work to industry for feedback and input on the application of their technologies or innovations.

Priority: High

Time Frame: Immediate

Recommended Lead Organization: Chemical Alliance Zone

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 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

Chemicals and Advanced Materials Strategy FOUR	**Assure West Virginia has a world-class workforce able to meet the current and future demands of the cluster**

Strategy Rationale: Noted workforce development experts Kenneth Gray and Edwin Herr note that:[iv] "Among all the riches a nation may possess, its people — its human resources, its human capital — is the most important. The value of this human resource depends not on size, however, but on the occupational and intellectual skills its members possess. At

least in this regard history is clear: a large "unskilled" population is a detriment to economic growth and to a high standard of living."

The root source of economic progress, higher wages, and higher standards of living throughout the U.S. can be found in high levels of workforce productivity — gained in part by technology but mostly through workforce skills and education. The chemicals and advanced materials sector is technologically intensive and dependent on highly skilled workers. Workers at every level from plant maintenance to operations must have specialized skills and training.

There is much misunderstanding regarding the skills and training that are required for a technology-focused workforce. Although workers with four-year college and even advanced technical degrees are essential, workers with other specialized skills and training are required as well. Creative workers with advanced degrees are a critically important driver of invention and new products and services, but other highly skilled workers are needed to get innovations into the marketplace. This requires and dictates attention to career and technical education, certificate and two-year programs, and the continuous upgrading of worker skills. **For the chemicals and advanced materials sector to thrive, attention to workforce skills and development is absolutely central to success**.

Specific action recommendations under Strategy Four are as follows:

Action CAM4.1 - Under the CAZ, form a working committee specific to work in CAM-related workforce development and education

Several years ago, leaders in WV's chemical industry recognized an impending need to replace retiring chemical operators over the ensuing 10 years or so. In response to that need, the Chemical Alliance Zone formed a Workforce Committee to address the labor force needs of WV's chemical industry. In addition, several groups, including the West Virginia Department of Commerce's Workforce Division, the Community and Technical College System of WV (WVCTCS), and the Robert C Byrd Institute have detected an increasing trend in demand for workers in various occupations in the CAM cluster. **Both coming retirements of baby boom workers and emerging product opportunities present a need for highly skilled workers**.

To ensure that West Virginia is able to meet the CAM industry's workforce needs, it is proposed that the CAZ Workforce Committee, in conjunction with WVCTCS and the WV Manufacturer's Association Chemical Industry Committee, oversee directions in workforce training and help ensure that the workforce meets industry expectations and needs, training is flexible in the face of changes in required occupations and skills, and retraining and enhancement programs are offered that meet the pace of changing occupations.

Priority: High

Time Frame: Immediate

Recommended Lead Organization: Chemical Alliance Zone, WV Community and Technical College System, WVMA Chemical Industry Committee

Intended Outcomes:

- **Increase employment** in private-sector, technology-based companies in West Virginia to reach national average by 2020

Action CAM4.2 - Engage industry in collaborations with community and technical colleges to develop courses and curricula to meet the current and emerging workforce needs of the CAM sector

Several years ago, in response to impending retirements of the baby boom generation in the chemical industry, the Chemical Alliance Zone, working with the Community and Technical College System of WV (WVCTCS) and the WV Manufacturer's Association Chemical Industry Committee (WVMA CIC), formed a **new Chemical Operator Training Program in WV**. That program is set to move to the WV Regional Technology Park once a new Advanced Technology Training Center is built.

Ensuring a pool of talent in processing technologies from technicians to engineers to scientists is essential for the long-term future of West Virginia in its energy, advanced materials and chemicals, and engineering & testing services industries. In today's knowledge-based economy, **businesses go where the talent resides**. WV industry leaders have recognized a strong longer-term need for technicians who have received hands-on skill training and experiential learning.

According to the National Governors' Association Cluster Strategies report, advancing such targeted skill training programs for specific industry clusters can offer a significant resource to industry. In particular, a cluster's particular needs and interests can be addressed and a continued flow of qualified workers — both new and retrained — can be supplied. Such training also allows students access to better and deeper programs, better employment opportunities, deeper understanding of industry, and more informal learning opportunities. Community colleges are often the site for such industry-driven programs, but four-year colleges and universities can also be key partners.

The Pennsylvania Partnership

- Joint effort between Penn State University and statewide colleges and universities
- Objective is to equip workforce with nanotechnology-based manufacturing and new product development skills
- Offers certificates, associate degrees, and baccalaureate degrees in Nanofabrication Manufacturing Technology
- Requires a hands-on, Capstone Semester at Penn State University Park.

WV's Chemical Operator Training program may benefit from other examples, including the Pennsylvania Partnership and the Indian Hills Community College in Iowa. In particular, the Lamar Institute of Technology in Texas is focused on process technologies for the chemical industry.

West Virginia has a unique opportunity to facilitate experiential learning for chemical process technicians as well as chemists and engineers through the use of pilot plant operations at the Tech Park. In addition, there is already a documented need for technician training to address retention and growth needs for the state's base of chemical firms, many of which are located in the vicinity of the Park.

It is proposed that the State continue to operate the Chemical Operator Training Program and to consider expansions or additions to that program based on industry's needs. A strong outreach to the K-12 system is also proposed, including teacher training and other creative activities. For example, a chemical process bus could travel around the state and offer hands on experience to K-12 students in concert with the teacher training, similar to what many states have done in the biotech arena.

It is also recommended that federal agency funding from NSF, Department of Labor, or Department of Energy be strongly pursued for both the industry training consortium and the K-12 teacher training and student engagement.

Priority: High

Time Frame: Immediate

Recommended Lead Organization: Chemical Alliance Zone, WV Community and Technical College System, WVMA Chemical Industry Committee

Intended Outcomes:

- **Increase employment** in private-sector, technology-based companies in West Virginia to reach national average by 2020

Action CAM4.3 - Assist in coordinating Internship programs with West Virginia CAM industry for students enrolled in relevant science and engineering disciplines at West Virginia's universities, colleges, and community colleges

The **benefits of internship programs for both students and employers** have been known and cited for many years. A WV program in chemical process engineering and technology development would allow: (1) students to gain valuable experience while earning good money, (2) industry to identify, train, and recruit future employees while meeting temporary labor demands, and (3) the state to better keep and train WV students and attract out-of-state students while helping to meet the industry's workforce needs. This could be advanced through tax credits to employers, waiving of payroll taxes on interns, or direct matching funds for internships.

Priority: High

Time Frame: Immediate

Recommended Lead Organization: Chemical Alliance Zone, WV Community and Technical College System, WVMA Chemical Industry Committee

Intended Outcomes:

- **Increase industry-supported R&D** at West Virginia's universities and colleges to match the national average by 2020
- **Increase employment** in private-sector, technology-based companies in West Virginia to reach 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, while West Virginia has a strong foundation to greatly strengthen its Chemicals and Advanced Materials cluster, 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.

> "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.

West Virginia does have significant strengths in several technologies, including its chemicals and advanced materials technology.

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

[i] Economic data for graphs and tables in this section provided by Eric Pennington (Graduate Research Assistant) and Tom Witt (Director), Bureau of Business and Economic Research, West Virginia University.

[ii] National Academies of Science, *Rising Above the Gathering Storm, Revisited*, 2010, pg 45.

[iii] Henry Chesbrough, *Open Innovation*, Harvard University Press, 2003.

[iv] Kenneth C. Gray and Edwin L. Herr. "Workforce Education." Massachusetts: Allyn and Bacon, 1998.

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

Additional information on the Chemical Alliance Zone and WV's Chemical Industry can be found at...

www.CAZWV.com

*This report is the **CHEMICALS AND ADVANCED MATERIALS REPORT** only.*

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www.TechConnectWV.com

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