NGA Policy Academy: Economic Development in the Clean Energy Sector

Mitch Horowitz, Managing Director & VP
Battelle Memorial Institute
Technology Partnership Practice
Battelle

Who is Battelle?

• The world’s largest non-profit independent R&D organization ($6+ billion in revenues)

• A worldwide leader in development, commercialization, and transfer of technology

• Conducts thousands of projects for over 1,100 government and industrial clients each year

• Manages or co-manages six national laboratories for the U.S. Department of Energy and two international laboratories

• Over 20,000 employees worldwide

Technology Partnership Practice is the economic development consulting organization for Battelle

TPP Areas of Expertise:

• Core Competency
• Cluster Analysis
• Benchmarking
• Strategic Planning
• Commercialization
• Program Design and Implementation
• Impact Assessment and Evaluation
• Entrepreneurial Development/ Venture Financing
• Technical Assistance and Problem Solving
Some Recent Battelle TPP Energy Projects

Central OH
Bioenergy, Bio-based polymers
Ohio Third Frontier
Solar, Fuel Cells/Energy Storage, Unconventional Gas

Renewable Manufacturing Gateway (PA/OH/WV)
Nuclear, Smart grid, Energy materials Cleantech (water/CO$_2$)

Arizona
Emerging Green Economy Sustainable Development Strategy

West Virginia
Energy recovery Power gen/combustion Carbon materials/by-products Environmental technologies Energy use efficiency

Mid-South Mississippi Delta
TN, MS, AR, KY, MO
Bioenergy; Bio-based chemicals and materials

Innovation Valley, TN
Nuclear Solar

Mississippi Energy Institute
Unconventional oil and gas Bioenergy
What Makes Energy-Related Development Different for States & Regions

• Regulated monopoly with traditional focus on low cost and reliability

• Capital intensive

• Disconnect between energy generation and job creation from clean energy activities

• Very embedded in overall economy, but is there a sufficient economic proposition? … non-energy industry deployment of advanced energy technologies is large potential economic driver, but will it be realized in the near term?
Today’s Discussion

1. Framing comprehensive strategies
2. Focus on asset mapping
3. Examples from Pittsburgh and Mississippi Delta
4. Discussion on challenges for clean energy development
Technology-Based and Cluster-Based Economic Development

Requires Attention to Every Link in the Development Chain

State and private sector commitment to building robust base of high-quality science and technology R&D and supporting infrastructure

Investment in infrastructure and personnel for application testing, technology piloting and scale-up activities

Strong basic research community able to attract competitive external grant funding

Academic and industrial research community and key partners committed to translating discovery into application and moving it towards commercialization

Financial and personnel commitment to intellectual property protection, technology transfer and in-state commercialization

Public and private sector risk capital for pre-seed, seed and venture funding rounds

Integration of existing businesses into the cluster, network and support for additional business growth from these enterprises

Facilitation and coordination of networking and cluster support activities

Presence of entrepreneurs and skilled human capital for business start-ups

Infrastructure and facilities to house new and expanding business enterprise

Generation of positive government, regulatory and business climate to meet competitive cluster needs

Commitment to targeted recruitment (domestic and international) of cluster businesses and supporting businesses

Integration into existing, expanding and new cluster businesses

Long-term, sustained commitment to development of the cluster by all parties

Education and workforce development to support cluster personnel needs

Successful and Expanding Business Clusters
New Realities Driving Global Competition
Placing Greater Emphasis on Finding Your Niche

- Global economic competition
- Rapid technological change
- Innovation as a development engine
- Education and skills for a competitive edge
- Sustainability, a growing imperative

Recognition that not all States are Built Alike and it is the Differences that can Best Guide Development Strategies

- Similar to private industry, states need to bring a strategic focus in understanding the opportunities that their industry and university base can sustain and leverage.
- Best practices in economic development calls on finding your niche:

  As Michael Porter points out: “Clusters are a striking feature of virtually every national, regional, state and even metropolitan economy, especially in more economically advanced nations … Clusters are not unique; however, they are highly typical—and herein lies a paradox: the enduring competitive advantages in a global economy lie increasingly in local things—knowledge, relationships, motivation—that distant rivals cannot match.”
Multiple Technology Intersections

Opportunities to link existing clusters and assets to energy applications (only a partial list).
Translating Core Competencies into Strategic Technology Opportunities

Strategic technology opportunities draw upon multiple core competencies and offer multiple development opportunities in significant expanding and emerging market niches.

Core Competencies found across University, Industry and Fed Lab Base using quantitative analysis and high level interviews

**Line of Sight**

Market Opportunity

**Strategic Opportunities in existing and emerging markets that draw upon Core Competencies**

**Technology Opportunity Identification**

- Identify Niches for Utah
- Strengths, Weakness, Opportunities and Threats
- Key market trends and drivers
Example of Strategic Plan Methodology

- Core Competency Review
- Best Practices/Benchmarking States/Regions
- State Economic Analysis
- SWOT Analysis
- Gap Analysis
- Technology Strategy
  - Mission/Vision
  - Strategies
  - Actions
  - Priorities
  - Financial Resources
  - Timeline
  - Implementation Plan
  - Measures of Success

Communication to Stakeholders
The Starting Point: Assets, Clusters and Competencies Evaluation

• Identification
  – Industry
  – Academic
  – Institutional

• Assets
  – Industry Development
  – Technology & Innovation
  – Infrastructure
  – Talent

• Quantitative Tools
  – Industry targeting analysis
  – Publications, Patents, Grants analysis, VC, SBIR, etc.
  – Omniviz™/cluster analysis of patents, publications

• Qualitative
  – Interviews of industry, universities, stakeholders
  – Focus Groups

• Existing reports and data
### Overall Evaluation of the Energy-Related Opportunity Areas for the Knoxville-Oak Ridge Innovation Valley

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</thead>
<tbody>
<tr>
<td>Nuclear Energy</td>
<td>Established</td>
<td>●●●</td>
<td>●●●</td>
<td>●●</td>
<td>●●●</td>
</tr>
<tr>
<td>Bioenergy</td>
<td>Emerging</td>
<td>●●</td>
<td>●●</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Energy Materials &amp; Applications</td>
<td>Established</td>
<td>●●●</td>
<td>●●●</td>
<td>○</td>
<td>●●●</td>
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</table>
Project Goals: Pittsburgh Region Renewable Manufacturing Gateway Project

- Bottom-up **identification of manufacturing firms** active in, or with specific assets making them likely to be able to participate in, renewable and alternative energy technologies and clean technologies production.

- Gathering **insight from key regional industries and stakeholders** in regards to regional opportunities for RCT-based economic development.

- Evaluating the **global and domestic competitive landscape** in RCT cluster development and potential niches in which the tri-state area appears to hold comparative competitive advantages.

- Evaluating the **tri-state region’s strengths and weaknesses** in regards to the key location factors required for manufacturing success in the RCT sector.

- Providing **recommendations, including a prioritized list of technology application areas in which the tri-state region has apparent opportunities for RCT-based economic development—with an emphasis on the manufacturing of RCT technologies.**
Renewable Manufacturing Gateway – Project Region
PA, OH & WV
Renewable Manufacturing Gateway Platforms

- Water and CO₂ Technologies
- Cross-cutting supports for component production in multiple renewable energy generation technologies
- Smart Grid Technologies
- Nuclear Power Technologies and Components
- Advanced materials for energy and cleantech applications
Strategic Focus for Renewable Mfg Gateway

- RCT Innovations
  - Industry
  - Universities
  - Federal Labs

- Business and Market Assessment
  - Specialized RCT Sector Knowledge

- Piloting and Testing Partnerships
  - Industry and Lab Resource Network

- Capital Access and Deal Facilitation
  - Connectivity to RCT business funders

- Manufacturing Partnerships
  - Network of Regional Manufacturers

- Commercialization by existing regional manufacturers
- Commercialization by new start-up business enterprises
- Attraction of RCT manufacturers to the region
- Contract manufacturing within the region
Recent Developments for RMG

Recent clients for business plan, management assistance and, in some cases, direct investment

- **Aither Chemicals** – proprietary technology to convert natural gas feedstock into higher-value petrochemicals
- **DACT Analytics** – portable and fixed infrared gas monitoring systems
- **Earthcure** – existing recycler of waste and now developing a precious metals refinery of medical waste
- **Mil Speck Re-Refining Oil Company** – establishing a cost effective distillation and hydro treating plant for waste lube oil back to basic oil
- **One Solar Energy** – start up for refining silicon for use in solar cells
- **RER Hydro** – Hydrokinetic electric generation turbine for use in river beds – partnership with Boeing

- June 2013 announcement of $500 million Renewable Manufacturing Gateway Capital Fund leveraging AFL-CIO pension funds to invest in energy and manufacturing companies with focus on Rust Belt
Regional Strategy for Bio-based Products in Mississippi Delta Region

- The Mid-South Mississippi Delta region’s land use is heavily agricultural.

  - 21.5 million acres of land is in farms (59.5% of total regional land area), of which 17.6 million acres is either cropland or pasture land.
  - The 98 counties contain almost 13.9 million acres of forestland (38.4% of total regional land area).
  - Together the row crop land, pastures, and forests cover 31.5 million acres or fully 87.2% of the total 98-county regional land area. Clearly the region is rich in biomass resources.
Multiple Development Opportunities from Mid-South’s Biomass Resource

Biomass Production

- Crops
- Crop Residues
- Dedicated Energy Crops
- Forest biomass
- Organic Waste Streams
- Algae

Pathways to new value-added biobased products

Energy | Fuels | Chemicals | Materials

Industrial Bioproducts and Fuels

Nutrition and Health Products

- Food and feed products
- Nutraceuticals, biopharming and specialty health products
## Regional Biomass Activities Underway: Advanced Biofuels & Chemicals

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Feedstocks</th>
<th>Project Details</th>
<th>Strategic Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated Physics of America, LLC.</td>
<td>Greenwood, MS</td>
<td>Wood residues</td>
<td>Pilot plant operational</td>
<td></td>
</tr>
<tr>
<td>Blue Fire Ethanol Fuels, Inc.</td>
<td>Fulton, MS</td>
<td>Wood residues</td>
<td>Commercial plant under development (19 mgy)</td>
<td>DOE</td>
</tr>
<tr>
<td>Buckeye Technologies, Inc.</td>
<td>Memphis, TN</td>
<td>Wood</td>
<td>Demonstration plant in Perry, Florida</td>
<td>Myriant Technologies, LLC.</td>
</tr>
<tr>
<td>Buckman Laboratories</td>
<td>Memphis, TN</td>
<td>Wood</td>
<td>R&amp;D programs underway</td>
<td></td>
</tr>
<tr>
<td>Dupont Danisco Cellulosic Ethanol LLC</td>
<td>Vonore, TN</td>
<td>Corn Cobs (switchgrass)</td>
<td>Demonstration plant</td>
<td>Genera Energy LLC., UT, ORNL</td>
</tr>
<tr>
<td>Enerkem Inc.</td>
<td>Pontotoc, MS</td>
<td>Wood residues</td>
<td>Commercial plant under development (20 mgy)</td>
<td>DOE</td>
</tr>
<tr>
<td>FutureFuel Chemical</td>
<td>Batesville, AR</td>
<td>Wood residues, other cellulosic feedstocks</td>
<td>R&amp;D programs completed</td>
<td></td>
</tr>
<tr>
<td>Infinite Enzymes, LLC.</td>
<td>Jonesboro, AR</td>
<td>Various cellulosic feedstocks</td>
<td>Enzyme production platform (biotech corn)</td>
<td>DOE, Arkansas State University</td>
</tr>
<tr>
<td>Pure Power Global Ltd.</td>
<td>Hong Kong</td>
<td>Wood residues</td>
<td>Financing demo plant to be located in TN</td>
<td></td>
</tr>
<tr>
<td>Verenium Corporation</td>
<td>Jennings, LA</td>
<td>Sugarcane bagasse</td>
<td>Demonstration plant</td>
<td>British Petroleum</td>
</tr>
</tbody>
</table>
Key Strategic Recommendation: Pursue Selective Near-Term Opportunities

Four recommended near-term bioprocessing opportunities for the region

- **Biomass Densification**
- **New Oilseed Crops**
- **Sweet Sorghum: Sugar Platform**
- **Biomass Fuels & Chemicals Demonstration Plants**

**Step #1** – Build a local supply chain with products we can make now.

**Step #2** – Attract technology to make advanced products in the future.
Overall Strategic Recommendations

• Pursue four near- to mid-term bioprocessing opportunities:
  – Co-firing biomass in regional coal power plants and process industry coal burners
  – Introduction of specialty oilseed crops and local crushing facilities
  – Development and demonstration of sweet sorghum-based ethanol production
  – Introduction of lignocellulosic-based ethanol and/or liquid fuel demonstration facilities

• Capacity building efforts:
  – Expand farmer networks
  – Establish a regional bioprocessing technology consortium
  – Establish a regional agricultural R&D network
  – Establish a regional business development office

• Expand bioprocessing workforce development

• Harmonize state policies and incentives

• Leveraging federal delegation from five states. Recognition that biomass is the key regional renewable resource
Key Issues in Advancing Comprehensive Roadmap

• To advance market niches in the clean economy requires focusing on both deployment and technology development.

• Specific challenges:
  – Measuring the clean economy
    - No specific detailed NAICS industry codes
    - Need to focus on specific innovation and deployment activities
  – Advancing industry-university partnerships
    - Stature of universities more than just based on size of research base – ability to address needs and requirements of industry
    - Need for systematic approaches to “business friendly” practices
    - Advancing open innovation approaches
Sizing the Clean Economy: A National and Regional Green Jobs Assessment

- Sensible definition that anticipates the BLS
- Bottom-up count of actual establishments

Key Findings:

- 2.7 million jobs in 2010
- Manufacturing intensive (26% vs 9% for total economy)
- 2/3rd of jobs in middle-wage, middle skill occupations
We break the clean economy down into five categories... with 39 smaller segments...

- **RENEWABLE ENERGY**
  - BIOFUELS/BIOMASS
  - GEOTHERMAL
  - HYDROPOWER
  - RENEWABLE ENERGY SERVICES
  - SOLAR PHOTOVOLTAIC
  - SOLAR THERMAL
  - WASTE-TO-ENERGY
  - WAVE/OCEAN POWER
  - WIND

- **ENERGY & RESOURCE EFFICIENCY**
  - APPLIANCES
  - BATTERY TECHNOLOGIES
  - ELECTRIC VEHICLE TECH
  - ENERGY-SAVING BLDG MATERIALS
  - ENERGY-SAVING CONSUMER PRODUCTS
  - FUEL CELLS
  - GREEN ARCHITECTURE/CONSTRUCTION SERVICES
  - HVAC & BLDG CONTROL SYSTEMS
  - LIGHTING
  - PROF ENERGY SERVICES
  - PUBLIC MASS TRANSIT
  - SMART GRID
  - WATER EFFICIENT PRODUCTS

- **GHG REDUCTION, ENVIRON MGMT & RECYCLING**
  - AIR/WATER PURIFICATION TECHNOLOGIES
  - CARBON STORAGE & MGMT
  - GREEN BUILDING MATERIALS
  - GREEN CHEMICAL PRODUCTS
  - GREEN CONSUMER PRODUCTS
  - NUCLEAR ENERGY
  - POLLUTION REDUCTION
  - PROFESSIONAL ENVIRONMENTAL SERVICES
  - RECYCLED-CONTENT PRODUCTS
  - RECYCLING & REUSE
  - REMEDIATION
  - WASTE MGMT & TREATMENT

- **AGRICULTURE/NATURAL RESOURCE CONSERVATION**
  - CONSERVATION
  - ORGANIC FOOD & FARMING
  - SUSTAINABLE FORESTRY PRODUCTS

- **EDUCATION & COMPLIANCE**
  - REGULATION & COMPLIANCE TRAINING
# Suggested Innovation Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Why Is It Important?</th>
<th>How Is It Measured?</th>
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</table>
| Publications                  | Peer-reviewed articles generated by university on green economy fields               | • Specialized searches of publication titles and abstracts along with key publication fields maintained by the Institute for Scientific Information.  
• Alternative would be to identify a set of key journals to track Arizona authors, but given multi-disciplinary nature of green economy fields do not recommend |
| Patents                       | A measure of generating new ideas in the form of intellectual property Includes both industry and universities | • Specialized searches of U.S. patents using the Thomson Delphion patent database → requires having the definition of green economy finalized.  
• Recommend focusing only on those patents whose inventors are based within a state |
| Federal Small Business Innovation Research Grants | A measure of emerging companies with product development ideas in green economy | • Categorize SBIR awardees in Arizona to identify those that fall within green economy fields and can track funding received. |
| Venture Capital Investments   | A measure of emerging renewable technology companies                                | • Based on venture capital funds invested in renewable energy companies. Data obtained from the Thomson Venture Xpert venture capital base. |
## Suggested Deployment Measures

<table>
<thead>
<tr>
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<th>Why Is It Important?</th>
<th>How Is ItMeasured?</th>
</tr>
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<tbody>
<tr>
<td>ISO 14,001</td>
<td>ISO 14001 is a series of international standards that have been developed to incorporate environmental aspects into business operations and product standards, such as identification and evaluation of aspects and impacts, development of objectives and measurable targets, implementation of programs, and on-going monitoring and review.</td>
<td>Companies need to apply and be certified</td>
</tr>
<tr>
<td>LEED, Energy Star and Building Codes of Local Jurisdictions</td>
<td>Demonstrates how extensive the focus of development community is on energy efficiency</td>
<td>LEED is a third-party certification program and the nationally accepted benchmark for the design, construction and operation of high-performance green buildings. ENERGY STAR represents building or manufacturing plants in top 25 percent based on EPA's National Energy Performance Rating System. Look into number of jurisdictions adopting specific national/international energy codes.</td>
</tr>
<tr>
<td>Production of Clean Energy</td>
<td>Examines specific capacities</td>
<td>Direct measures of electricity generation from hydro, wind, solar, nuclear, unconventional gas</td>
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</tbody>
</table>
Insights on Promoting Broader Industry-University Partnerships

Key guidance from industry executives

- Access to talent and well-trained graduates is a very important and common area of concern for corporate leaders

- Advance industry consortia
  Many benefits to industry including:
  - Early look into new technologies
  - Further talent generation
  - Access to shared use equipment

- Companies need a clear pathway on proprietary technology development with universities
  - Master agreements are an effective mechanism

- Key area for industry-university partnerships is to pursue national research grants

In project with University of Pittsburgh to enhance its Energy Center, Battelle held discussions with 16 senior corporate executives, including from:
- Rolls Royce
- CONSOL Energy
- Westinghouse
- Siemens Energy
- Eaton
- ABB
- Bayer
- Mitsubishi Electric
**“Business Friendly” Approaches on Industry Collaborations**

<table>
<thead>
<tr>
<th></th>
<th>Business Friendly Practices</th>
<th>Best Practice Example of Business Friendly</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relationship Building</strong></td>
<td>Has a clear point of contact for industry</td>
<td>Georgia Tech, Purdue, Iowa State</td>
</tr>
<tr>
<td></td>
<td>Systematically reaches out to business to “learn their needs” rather than reacts to requests</td>
<td></td>
</tr>
<tr>
<td><strong>R&amp;D Collaborations</strong></td>
<td>Creates more tailored programs for joint research, shared facility use, student experiences and/or professional development.</td>
<td>Rutgers, Penn State, CMU</td>
</tr>
<tr>
<td><strong>Technology Commercialization</strong></td>
<td>Enable “industry funded” research to be owned by industry with clear terms and conditions</td>
<td>Penn State, University of Minnesota</td>
</tr>
<tr>
<td></td>
<td>Standardized terms for industry partners to license technology</td>
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Next Generation – Addressing the Opportunities and Challenges from “Open Innovation”

• Large firms have “outsourced” much of R&D and become more “systems integrators” and “solutions providers”

• Increasing importance of small innovative technology firms in the role of moving research to applications and commercialization
  
  – In US industry, over than half the scientists and engineers engaged in R&D are in small firms (54.8% -- NSF Science Indicators, 2006)

• The challenge is to obtain the “voice of the customer” early in the process of R&D
  
  – No one organization has all the answers or capabilities
Open Innovation – Opportunities for Building Partnerships --- Large, Small Technology, Manufacturing Supply Chain

Initial Phase: Industry-University Collaboration on Pre-Commercialization Research

Agent & Process Manager: Penn State University & Partners

No one organization has all the answers or capabilities!
What Makes Energy-Related Development Different for States & Regions

• Energy Development Environment
  – Regulated monopoly
    - Traditional focus on low cost and reliability
  – Capital intensive
  – Disconnect between energy generation and job creation from advanced energy activities
  – Very embedded in overall economy, but is there a sufficient economic proposition
    - Non-energy industry deployment of advanced energy technologies is large potential economic driver, but will it be realized in the near term?

• Implications
  – Disruptive vs. Incremental Changes
  – Need to build innovation into business model for utilities
    - Need for an “energy specific” translation model from innovation to market adoption
    - Create utilities as customers for innovation
  – Advance new financing pools & incentives for advanced energy
    - Create purchasing power by utilities through regulatory reform
    - Create energy financing authorities
    - Need for incentives to deploy energy technologies
    - ????
Contact

Mitch Horowitz
Managing Director and Vice President
Battelle Memorial Institute
Technology Partnership Practice
Phone: 240-462-5456
E-mail: horowitzm@battelle.org

TPP Areas of Expertise
- Technology-Based Economic Development – Strategies and Action Plans
- Core Competency Identification
- Cluster Analysis and Cluster Development
- Technology Talent & Workforce Development
- Entrepreneurial Development and Capital Planning
- Technical Assistance and Problem Solving
- Program Design and Implementation Services
- Benchmarking
- Economic Impact Assessment