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**Opportunities for Growing
the Environmental
Technology Cluster in
Pennsylvania**

**Submitted to the Ben Franklin
Technology Center of Western
Pennsylvania**

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Executive Summary

In 1997, Governor Ridge and the Ben Franklin/IRC Partnership Board initiated Technology 21, a strategic planning process to promote the development of the state's technology base. The Board commissioned the Battelle Memorial Institute in 1998 to benchmark the Partnership against leading technology assistance programs and develop an action plan for the Partnership to implement the Technology 21 strategy. The board also charged each Ben Franklin Technology Center with the task of developing competitiveness strategies for each technology cluster.

The Ben Franklin Technology Center of Western Pennsylvania (BFTC/WP) was appointed the lead center for the Environmental Technology (ET) Cluster. The BFTC/WP contracted the Center for Economic Development at Carnegie Mellon University (CED) to conduct the analysis of the cluster. The CED's analytical capabilities and its experience in the first phase of the Technology 21 process offered expert knowledge and resources for the data analysis and focus group discussions that are the core of this report and its recommendations.

The CED analyzed a variety of data on the performance and scope of the ET cluster in Pennsylvania. This analysis is presented in the section on Growth Trends and some Key Facts are summarized below. The notes on the data sources and methods can be found in Appendix 2. The CED also conducted focus group sessions with industry representatives for the cluster in each Ben Franklin region. In some cases, the focus group sessions were supplemented by targeted surveys to verify information gleaned from the focus group participants. The goal of these sessions was to get statewide representation of the cluster and to identify common areas that pertain to the cluster. The regional differences were found to be minimal in terms of the needs of the companies or different strategies to support the cluster in that region. The section, Regional Highlights on page 11, reviews these differences.

Key Facts

- Pennsylvania ranked 6th in employment and 5th in establishments in 1995.
- The ET Cluster has declined at the national and state levels.
- Pennsylvania's ET Cluster is specialized in the healthiest sectors of the cluster, but factors in the state business climate severely depressed growth.
- Innovation does not drive the ET Cluster, which limits the role that technology and R&D play in promoting growth.
- Process technologies and bioremediation present possible growth sectors for the cluster.
- International markets also present opportunities for the cluster.
- Efforts to support the ET Cluster should be integrated with the Advanced Manufacturing Cluster.

Summary of Opportunities

The recommendations for the Environmental Technology cluster are derived from the industry-based focus group sessions and the data analysis summarized in the Growth Trends section. These opportunities are summarized in Table 1: Opportunities for the ET Cluster. In addition, we have made every effort to provide consistency with previous work on Technology 21, particularly the strategy developed by Battelle. In order to make those connections clear, we have provided a chart of the Battelle recommendations (See Appendix 1: Summary of Battelle Recommendations).

The Battelle report recommended eight key strategies for growing Pennsylvania’s technology-based economy. Five of those eight strategies figure prominently in the opportunities for the Environmental Technology cluster identified in this report. The strategies are:

- Establish new partnerships, and strengthen existing partnerships with PA’s universities and colleges.
- Improve PA’s entrepreneurial culture and support for new and existing technology-based companies.
- Support the growth of industry clusters in key technology sectors.
- Assist the commonwealth in ensuring that PA has knowledge workers demanded by technology-intensive industries over the coming decade.
- Serve as a key advocate for technology-based companies, both large and small.

Table 1: Opportunities for the ET Cluster

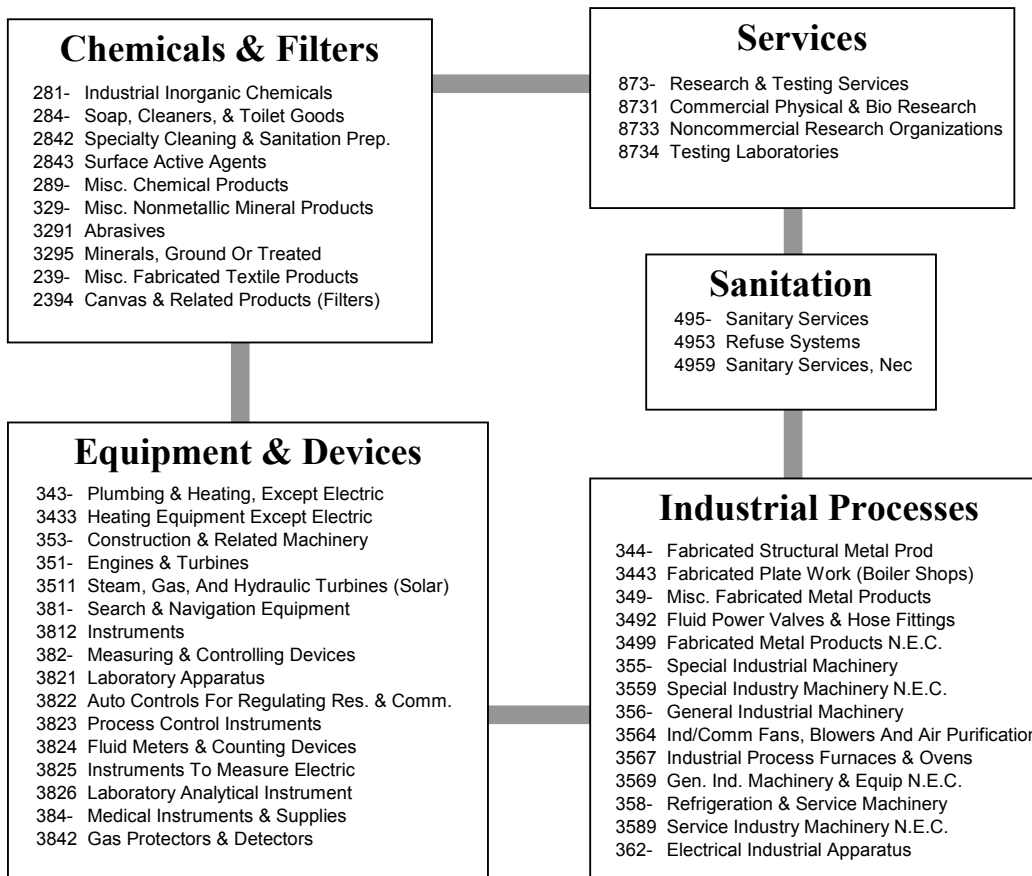
| Goals | Strategies | Opportunities |
|--|--|--|
| 1 – Develop the Technology Infrastructure | A. Promote environmentally focused partnerships that link ET firms, industry, universities, and the state. | <ul style="list-style-type: none"> • Focus an outreach effort to help ET firms access existing financing and export programs. • Integrate ET firms into an effort to promote process improvements in PA industries |
| 2 – Promote Innovation and Entrepreneurship | A. Support the growth of industry clusters in key technology sectors | <ul style="list-style-type: none"> • Encourage responsiveness to industry timeframes and regulatory issues • Support SBIR, STTR and ATP applications |
| | B. Improve PA’s entrepreneurial culture and support for new and existing technology-based companies | <ul style="list-style-type: none"> • Provide in-depth commercialization mentoring and assistance • Facilitate the formation of industry networks and associations |
| 3 - Provide Leadership on Technology Issues | A. Serve as a key advocate for technology-based companies. | <ul style="list-style-type: none"> • Explore changes in state environmental regulations to support adoption of innovative solutions • Support creation of an industry led science and technology group at the state level to serve as a regulatory review panel and advocacy group |

Note: This chart is adapted from the recommendations in the Battelle report, September 1998.

Growth Trends

Environmental Technology is a difficult cluster to define because many companies do not define themselves as “environmental” but as engineering, construction, or biotech. The Environmental Technology cluster can include areas as broad as remediation, filtration, waste treatment, chemicals, sensors, and more. Based on definitions developed by others and our own research, this report uses a broad definition of Environmental Technology that includes the industrial sectors listed in Figure 1.

Figure 1: Components of the ET Cluster



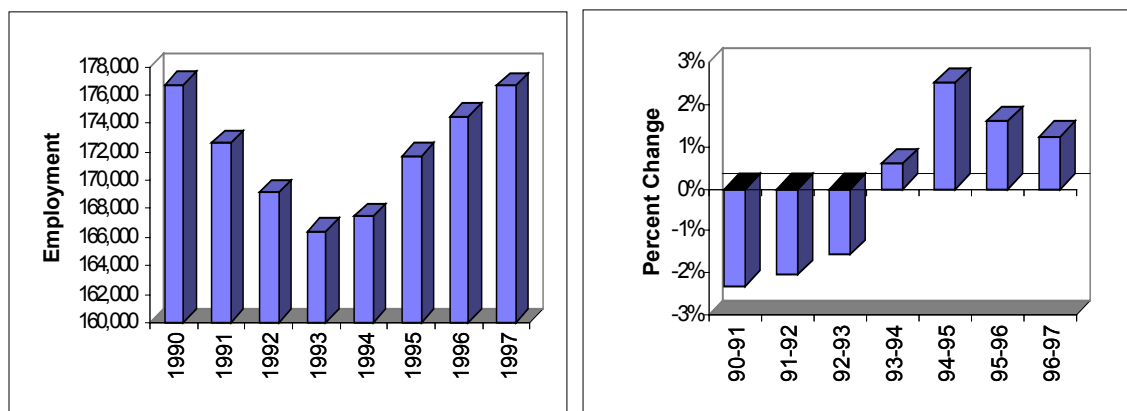
The Environmental Technology cluster is the largest technology cluster in the state in terms of employment, totaling 176,600 jobs and ranks second only to Information Technology with a total 1997 payroll of \$7.1 billion and nearly 4,300 establishments. However the cluster is losing employment in the state and the nation. In the US, employment in the cluster decreased by 1.1% between 1990 and 1995, while the number of establishments increased 9.5%¹. In Pennsylvania, the ET sector decreased employment by 3%, while adding 16% more establishments between 1990-1995 (See Figure 2). There was some post 1995 growth in the cluster that nearly brought

¹ Source: County Business Patterns, 1990 and 1995.

employment back to 1990 levels and generated a 22% increase in the number of ET firms between 1990-1997².

The decline is also attributable to a slowdown of regulations in the US and a shift from specialized environmental activity to general construction and engineering. Table 2 presents the growth by sub-clusters in Environmental Technology. The negative trends for the cluster have occurred despite growth in some of the broader sectors of the cluster. For instance, Chemical and Services have grown as broad sectors in the state, but the trends for the “environmental” portions of those sectors have been negative. This may reflect a decrease in business and employment, or it may reflect the effort by environmental firms to broaden their markets and re-position themselves as more than an “environmental” company. The cluster is shifting from *clean-up* to *clean processes* and *prevention*. In order for growth to occur, the ET cluster cannot rely on regulation as a driver. Industry regards environmental issues and solutions as cost centers not profit centers. Industry needs technology that saves money or improves process, therefore ET firms should focus on a cost saving versus an environmental compliance approach.

Figure 2: Employment in the ET Cluster



Source: PA Department of Labor and Industry, ES202 database.

Table 2: Growth by Sub-Clusters

| Sub | 1990 | 1997 | Change | Percent Change |
|---------------|--------|--------|--------|----------------|
| Chemical | 20245 | 19974 | -271 | -1% |
| Equipment | 43302 | 37934 | -5368 | -12% |
| Industrial | 39248 | 39787 | 539 | 1% |
| Sanitation | 5784 | 8504 | 2720 | 47% |
| Services | 16559 | 14660 | -1899 | -11% |
| Not-disclosed | 51583 | 55804 | 4221 | 8% |
| Total | 176721 | 176663 | -58 | -0.03% |

Source: PA Department of Labor and Industry, ES202 database.

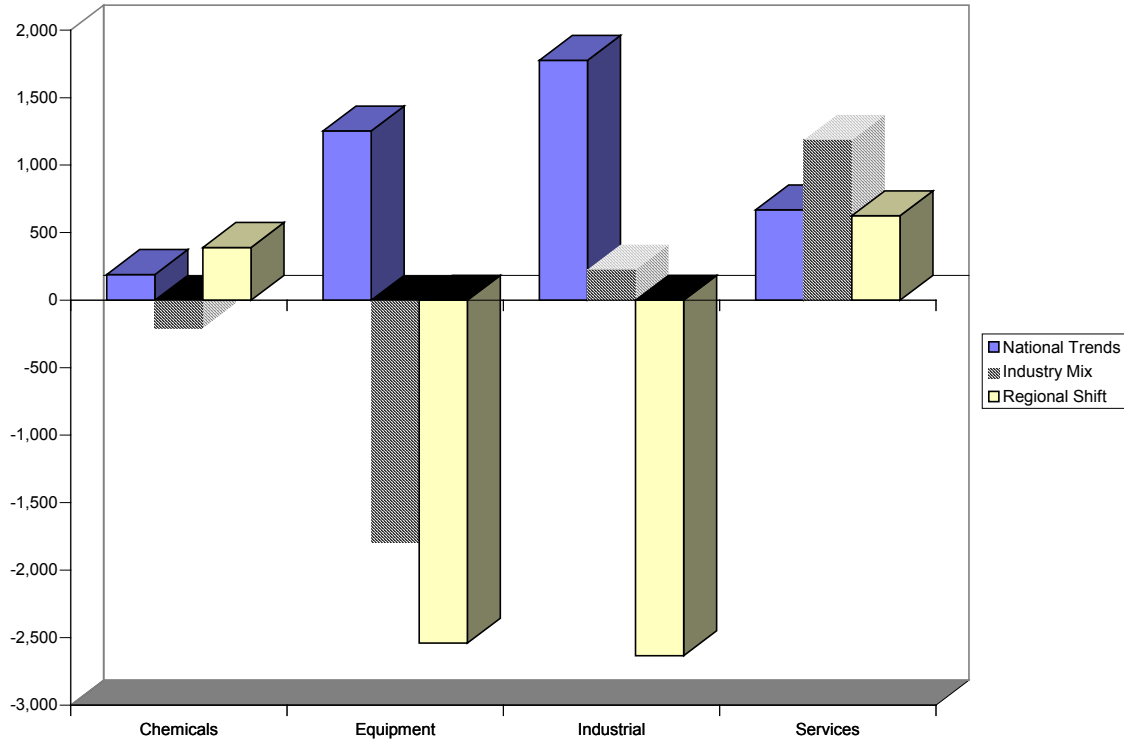
² Source: PA Department of Labor and Industry, ES202 database.

Another aspect of the decline in the ET cluster is that the demand for pollution controls has softened, as many companies have already implemented systems. The domestic market demand has shifted from major capital investments in water and sewage treatment to improvement and optimization of existing systems, although there is still the need for installation in some rural areas. This market for optimization is quite large by some estimates. However, the problem is that the market often cannot afford to pay for new installations or even optimization of existing systems. In addition, decreased defense spending has caused some national labs to provide environmental services – further increasing competition. The hardest hit sector has been remediation, which has become a very competitive commodity business. Growth is occurring overseas in sewage and water treatment, but not in high tech products. Pennsylvania’s ET cluster could benefit from increasing export activity. These firms would require assistance in identifying markets and countries with less regulated approval processes, but which are nonetheless concerned about environmental quality.

In general the focus groups were pessimistic about the future of the industry to produce big profits or create a large number of jobs. Strict environmental regulations and technology approval processes have both created and constrained the market for ET firms and the state can do little about the national market. Conservatism by industry regarding “environmental” measures further dampens the potential from new technology. In addition to regulatory constraints, the ET Cluster does not generate revenues comparable to biotechnology or information technology firms. The ET Cluster can add value by improving the quality of life and the efficiency of manufacturing in the state.

The decline in the ET Cluster is not shared by all segments of the cluster. Shift-share analysis enables us to examine the state’s ET Cluster to identify how it has been affected by national economic trends (national shift), the composition of the cluster in growing or declining sectors (industry mix) and by the state business climate (regional shift). The shift-share analysis for the ET cluster indicate that national trends had a positive influence on growth in the every sub-cluster. (See Figure 3). Unfortunately, Pennsylvania’s strong concentration in Chemicals and Equipment and Devices contributed to the ET cluster’s poor performance because these sectors have been in decline. However, the business climate in the state (regional shift) had the most significant and negative impact on the cluster’s performance. Furthermore, most of that negative impact was concentrated in Equipment and Devices and Industrial Processes. The outlook for the cluster is not as dismal as it appears, because the state has a greater ability to alter its business climate than it does national economic growth or the composition of industry.

Figure 3: Growth Drivers in the ET Cluster, 1990-1995



If the future of Environmental Technology is in clean processes and prevention, then Services and Industrial Processes will be the key sub-clusters. Equipment and Devices will most likely be hampered by barriers to innovation, and the Chemicals sub-cluster will serve primarily as a supplier rather than a growth driver. The negative regional shift in Industrial Processes deserves attention as one of the most notable negative influences to cluster growth and potentially one of problems most amenable to change. The strategies outlined in this report could help to remove some of the constraints on the competitiveness of the cluster. Improving the coordination between the development of new Environmental Technology and the adoption of such technology by industry should help to improve the growth potential of the cluster in Pennsylvania.

Opportunities

1. *Technology Infrastructure*

A. Promote environmentally focused partnerships that link ET firms, industry, universities, and the state.

Technology is not a driver for growth or profits in the ET Cluster. Innovative technology is often excluded from contracts by regulators and by industrial firms. “The innovative technology in our business is twenty years old,” said one participant, echoing the sentiments of many in the focus groups. As a whole the ET industry is not innovative and there are many barriers to proving a new technology. These barriers include the regulatory process as well as the conservative approach of industrial customers. There are some opportunities for technological innovation in the environmental instrumentation field. These instruments are often insufficient for many monitoring tasks and do not work well with integrated, automated production systems. Bioremediation also presents some new opportunities, but bioremediation solutions will be accepted slowly.

Pennsylvania accounts for 2.0% of the total University R&D expenditures in Environmental Sciences.³ This field accounts for only 2.4% of the University R&D expenditures in the state of Pennsylvania, but is 6.3% of the expenditures in the US. Pennsylvania has held a stable two percent of these R&D expenditures from 1993-1996. Over this period, expenditures in Environmental Science R&D grew 32% in the state, compared to 22% for the rest of the nation. The Central and Northern region and the Western region are the only two regions with significant R&D expenditures in this field.⁴ Given the lack of an innovation driver in the ET Cluster, the payoff from expanding the state’s R&D capabilities in this field is likely to be minimal.

A demonstration or certification process for new environmental technologies could reduce or remove the barriers to innovation-driven growth. The Civil Engineering Research Foundation (CERF) provides independent validation of technologies, but it is expensive. Low profit margins and the conservativeness of the clients makes it difficult for small and medium-sized companies to afford such demonstrations. It is also important to demonstrate cost advantages, not just technological refinement or environmental worthiness. The universities could be helpful in establishing the demonstration and certification process. The participants suggested a program like the federal STTR program to increase industry-university interaction. Such a program could be integrated with an effort to help small companies to validate or demonstrate their technology.

International markets present some opportunity for ET firms, many of whom have seen large increases in export sales in the past three years. Many parts of the world have

³ Source: NSF, Academic R&D Expenditures, FY 1996, Tables B-23, B-31, and B-54.

⁴ Approximately \$3 million or 11% of the state’s expenditures was not reported at the institution level, therefore the expenditures could not be distributed to BFTC regions.

yet to make the investments in capital intensive sewage and water treatment systems or in pollution control. Furthermore, the lower level of regulation in these markets, compared to the US, makes it easier to sell ET products and services. However it is difficult for small firms to access these markets. The costs are high and the time to complete a sale can be very long. The firms that are most heavily involved in exporting are at the mercy of exchange rates and expressed interest in loans or other assistance that would ease the burden of exchange rate fluctuations. Canada developed a CD-ROM for marketing their ET firms and products that has been used effectively to win international business. The state could assist IT firms by helping to identify qualified agents and distributors, increase exposure through trade shows, and provide financial and advocacy support to combat subsidized foreign competition.

The ET Cluster could benefit from a partnership with the BFTCs and the Industrial Resource Centers (IRCs) to promote adoption of advanced process technologies that are environmentally clean. The participants felt that the IRC program could do more to promote growth in the Environmental Technology cluster. The participants recommended a voucher system for manufacturers to get advice from private consultants, IRCs or ET firms. The current system directs these manufacturers to the IRCs, which are effectively competing with the ET firms. A partnership between IRCs, BFTCs and ET firms could focus on implementing some key process technologies that would act as a demonstration of the value and capabilities of the ET cluster and serve to certify new environmental technology for industrial applications. This joint effort should be integrated with efforts to promote the advanced manufacturing cluster.

Opportunities

- Focus an outreach effort to help ET firms access existing financing and export programs.
- Integrate ET firms into an effort to promote process improvements in PA industries

Key Players

DCED, Team PA, IRCs, BFTCs

2. Innovation and Entrepreneurship

A. Support the growth of industry clusters in key technology sectors

In the Environmental Technology cluster, the time to market is increased by regulatory constraints. The feedback from the focus groups encouraged the Ben Franklin program to consider the different commercialization timeframes and regulatory issues of getting environmental technology to market. Given these conditions and the relatively lower profits, there is a lack of venture capital and other financing for ET firms. The BFTCs could help ET firms to attract more SBIR funds, or to build consortiums of ET firms to capture more of the money and work that larger firms are winning. The

participants in the Environmental Technology displayed mixed preferences for larger investments and advocated a case-by-case approach. They also suggested that the BFTC should continue to focus on assisting growth companies and avoid funding proposals that are short-term bailouts of a company.

Opportunities

- Encourage responsiveness to industry timeframes and regulatory issues
- Support SBIR, STTR and ATP applications

Key Players

BFTCs, BF/IRC Board, USDOC, US SBA

B. Improve PA's entrepreneurial culture and support for new and existing technology-based companies

The focus groups also endorsed the Ben Franklin program's emphasis on concurrent business and technology development. The peer review process adds value by bringing together venture capitalists and technology people, but the clients do not get enough of the feedback from these reviewers. In addition to more feedback from the reviewers, the participants encouraged a more intensive business review and increased commercialization focus. Ben Franklin also adds value in the form of networking and support services. Ben Franklin has been an important source of help in the areas of marketing, sales and as a liaison to other sources of financing.

Associations and industry groups for ET firms are not available in every region in the state. The Environmental Business Network that operates in Western Pennsylvania reaches a limited territory. Networking initiatives should emphasize face to face interaction over electronic systems and should provide access to advice from industry and national experts. They would also encourage networking and counseling events that have a diversity of themes and in which the attendees are not all environmental consultants or competitors. Networking activities were viewed as the role of an association. Such associations should also strive to bring together industry and regulatory representatives, but government would have to relax its rules to allow staff to attend such events.

Opportunities

- Provide in-depth commercialization mentoring and assistance
- Facilitate the formation of industry networks and associations

Key Players

BFTCs, Universities, Technology Councils

3. Leadership in Technology Issues

A. Serve as a key advocate for technology-based companies.

The problems in the regulatory climate filter down from the federal level to the state and local enforcement officials, which limits how much the state can change. However, Pennsylvania's multitude of local governments, each with their own set of officials and regulations, further complicates the process of approving or certifying new technology. The ET cluster is similar to the Biotechnology cluster in the strong presence that regulatory agencies play in defining and limiting technology opportunities. However, ET lacks the "upside potential" that biotech offers. Furthermore, the regulatory system in ET tends to discourage rather than reward innovation. Many new ET advances are excluded from bidding processes and therefore cannot even get the chance to demonstrate their worth. The state should implement a mechanism for challenging regulatory decisions with some sort of scientific review panel because these decisions are often not science based. Another suggested change for the state would be to provide liability waivers for the use of PA environmental technologies or firms. Another approach would be to help in bonding smaller companies, or perhaps even create a liability pool that would reduce the risk faced by any one firm.

The participants expressed interest in the BFTCs serving in an advocacy role with regulators and industry. The biggest impact for the cluster would result from directing incentives to industry to adopt "clean" processes rather than providing support for ET firms. They also suggested that an advocate could help to interpret and promote understanding of environmental regulations, as well as encouraging the state to accept innovative solutions to environmental problems. Currently, the state has no incentive to innovate with new technology – the regulatory pass-down from the federal government requires more reporting for innovative solutions and offers no rewards to the regulator. It is unclear how to make this happen, although everyone agreed that the regulatory climate would improve with more cooperation between the EPA and DEP. Pennsylvania should also participate in national or multi-state consortiums for joint or reciprocal approval of new technologies, such as the effort by several states in the Great Lakes region. Another alternative is an effort by the Concurrent Technologies Corporation (CTC) in Johnstown to address the lack of standard solutions for the defense industry – which could be a model for the environmental field.

Opportunities

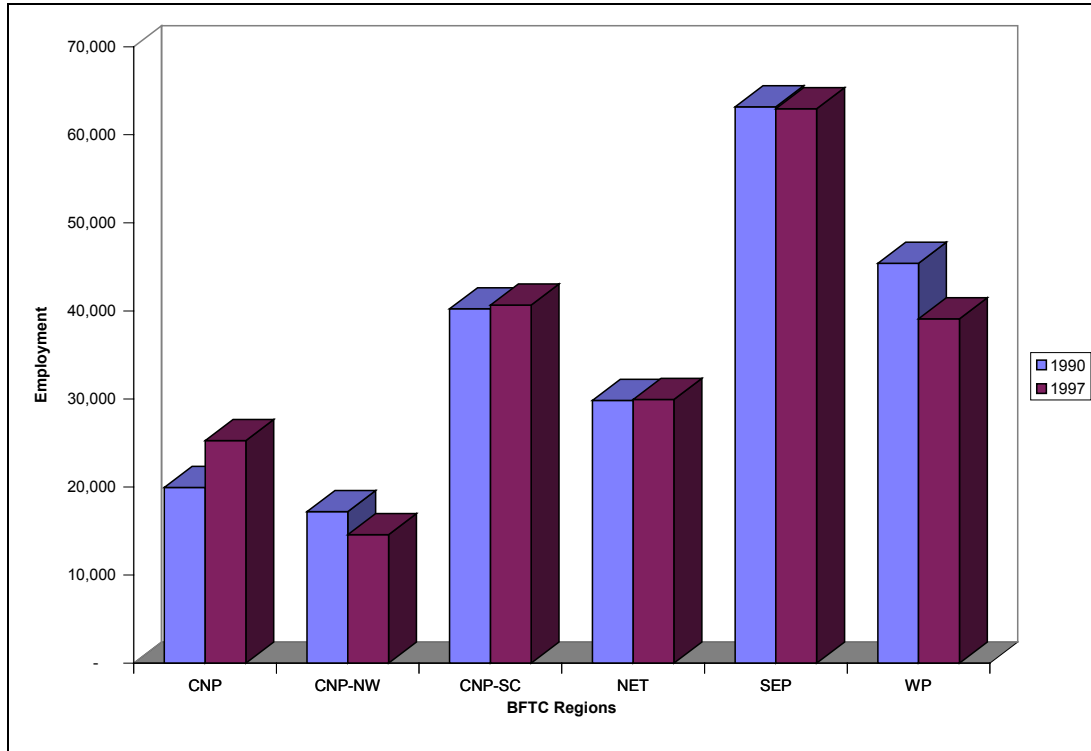
- Explore changes in state environmental regulations to support adoption of innovative solutions
- Support creation of an industry led science and technology group at the state level to serve as a regulatory review panel and advocacy group

Key Players

Governor, DCED, BFTCs, DEP, EPA, IRCs

Regional Highlights

Figure 4: Environmental Technology by Region, 1990-1997



Source: PA Department of Labor and Industry, ES202 database.

Pennsylvania's ET firms are concentrated in Southeastern (SEP), Western Pennsylvania (WP) and the South Central region (CNP-SC). According to this data, the Central and Northern region around State College is the only portion of the state that experienced significant growth in the cluster. The Western and Northwestern sections of the state suffered the most severe loss of employment in the ET Cluster. Table 3 indicates that the number of ET establishments increased across the state, despite the employment decreases. These changes are consistent with the restructuring described in the focus group sessions.

Table 3: Change in Establishments, 1990-1997

| Region | 1990 | 1997 | Percent Change | Share of State's Growth |
|--------|-------|-------|----------------|-------------------------|
| CNP | 345 | 434 | 26% | 12% |
| CNP-NW | 217 | 265 | 22% | 7% |
| CNP-SC | 566 | 712 | 26% | 20% |
| NET | 554 | 659 | 19% | 14% |
| SEP | 1,650 | 1,855 | 12% | 28% |
| WP | 997 | 1,141 | 14% | 20% |

Source: PA Department of Labor and Industry, ES202 database.

Central and Northern Region

The Central and Northern region, due to its size, is divided into its satellite regions for this analysis.

CNP (State College)

The portion of the Central and Northern region around State College experienced the largest increase in ET employment (27%) of any of the regions. The region also enjoyed a 26% increase in ET establishments. The growth in the cluster was fueled by strong performance in the Industrial Processes, Equipment and Devices, and Sanitation.

The region's dominance of Pennsylvania's R&D activity in the environmental fields may also account for this region being the only one in the state to have significant growth within the cluster. ET related R&D expenditures in the universities accounted for just nearly 7% of the University-based R&D in the region in 1996. Environmental Science is a specialty of the region's research universities. The region historically accounts for approximately 90% of the statewide expenditures in the field. University-based R&D expenditures in Environmental Science in the CNP region have increased 37% between 1993 and 1996, however in 1995-1996 funding decreased by 5% in the CNP region. Nonetheless, this region continues to dominate R&D activity in this area.

CNP - Northwest (Erie)

This region lost 15% of its employment in the ET Cluster between 1990 and 1997 and had an increase of 22% in the number of establishments. The region had a strong performance in the Equipment and Devices, Sanitation and Industrial Processes sub-clusters. However, Services and Chemicals depressed the overall performance of the cluster.

CNP - South Central (Harrisburg)

This region increased ET employment by a meager 1%, but posted a strong increase of 26% in the number of establishments. The Sanitation and Services sub-clusters provided the strongest growth in the cluster in this region. While Chemicals, Equipment and Devices and Industrial Processes all posted losses between 1990 and 1997.

Northeastern Tier Region

This region essentially maintained its 1990 base of ET employment, adding 112 jobs. The number of ET establishments increased by 19%, or 105 firms. The ET Cluster in Northeastern Pennsylvania benefited from growth in Sanitation and Services, while Chemicals and Equipment and Devices suffered significant declines.

Southeastern Region

Southeastern Pennsylvania nearly maintained its 1990 employment, losing only 219 employees for the ET cluster. However, the region had the smallest proportional increase in the number of establishments (12%) in the ET Cluster. Sanitation and Chemicals helped to stem the loss of ET employment by posting relatively strong growth, while Industrial Processes and Equipment and Devices depressed the cluster's performance in the region.

Western Region

This region lost 14% of its ET employment and increased the number of ET establishments by only 14%. Weak growth in Sanitation and Services prevented the region from offsetting losses in Chemicals, Industrial Processes and Equipment and Devices. This region posted the worst overall performance for the ET Cluster in the state, despite being one of only two regions with any cluster-related university R&D activity. Certainly in Western Pennsylvania, innovation has not been a driver for the ET Cluster.

ET related R&D expenditures in the universities accounted for less than 1% of the University-based R&D in the region. Environmental Science is the smallest field in terms of R&D expenditures for the region's research universities. The region has fluctuated at approximately 10% of the statewide expenditures in these fields. University-based R&D expenditures in the region decreased 3% between 1993 and 1996, due primarily to a large decline in 1993-1994 that has not been offset by increases in 1994-1996.

Appendix 1: Summary of Battelle Recommendations

| Objectives | Strategies | Actions |
|--|---|--|
| # 1 Make Pennsylvania a leader in innovation and commercialization of technology | Establish new partnerships, and strengthen existing partnerships with PA's universities and colleges | <ul style="list-style-type: none"> Institutionalize an Ongoing University President's Forum Establish an Innovation & Commercialization Network in partnership with PA's universities and colleges |
| | Attract increased federal research and development funding | <ul style="list-style-type: none"> Work with the Commonwealth to create a Strategic Technology Investment Fund |
| #2 Ensure Pennsylvania has the pre-seed, seed and related financial assistance to start and grow technology-intensive businesses | Continue to invest, in partnership with the private sector, in new and expanding technology-based businesses. | <ul style="list-style-type: none"> Establish the Technology 21 Seed Capital program providing larger multi-year investments to selective firms Expand and increase support of SBIR, STTR and ATP applicants Establish a BFTC Reinvestment Pool |
| #3 Make PA one of the leading states in the birth, nurturing, growth and survival of young, small technology firms by encouraging a thriving entrepreneurial culture. | Improve PA's entrepreneurial culture and support for new and existing technology-based companies | <ul style="list-style-type: none"> Provide in-depth assistance to entrepreneurs and small technology-based companies Establish an entrepreneurial education initiative Assist communities to build entrepreneurial economies |
| | Support the growth of industry clusters in key technology sectors | <ul style="list-style-type: none"> Support the development of industry competitiveness strategies for each of the industry clusters ** Facilitate the formation of industry associations or communities of interest. |
| #4 Ensure PA has the knowledge workers demanded by technology-intensive industries over the coming decade. | Assist the commonwealth in ensuring that PA has knowledge workers demanded by technology-intensive industries over the coming decade | <ul style="list-style-type: none"> Act as catalyst for creative approaches to education and training Undertake surveys of the education and training needs of key industry clusters Support training consortia |
| #5 Improve PA's image as a world class technology leader. | Serve as a key advocate for technology-based companies, both large and small. | <ul style="list-style-type: none"> Conduct annual survey of CEOs of PA's technology companies Support creation of an industry led science and technology advocacy group at the state level |
| | Increase understanding in the marketplace, both inside and outside of PA, of the high tech capabilities of the state's workforce, support industries, education and training institutions | <ul style="list-style-type: none"> Undertake a statewide promotional campaign to increase knowledge and understanding of S&T, the role it plays, and opportunities it provides. |

Source: Battelle Memorial Institute. September 1998. *Positioning Pennsylvania's Ben Franklin Technology Centers for the 21st Century.*

** This report on the Environmental Technology Cluster represents that action item.

Items in Bold-Face type correspond to items in Table 1: Opportunities for the ET Cluster.

Appendix 2: Notes on Data and Methods

Industry Focus Groups

The CED facilitated industry-led focus groups for the cluster in each Ben Franklin region. These focus groups were followed up with targeted surveys, as well as electronic mail. The CED maintained a web site to encourage feedback from these participants at every stage of the process. More than thirty professionals participated in these sessions statewide. Each focus group session consisted of no more than ten persons and lasted approximately four hours to allow for in-depth discussion of the opportunities and constraints facing the cluster. The goal of these sessions was to identify *common* needs and to find a *consensus* for issues that would benefit from state action.

Data Analysis

Sources for industry data included the Pennsylvania Department of Labor and Industry, County Business Patterns, and the National Science Foundation. Data on employment, establishments and wages at the four digit SIC level for the cluster for 1990 to 1997 was provided by the Pennsylvania Department of Labor and Industry. This data is derived from the state's ES202 database and presents the most up to date information available on the state's industries, but it cannot be used for comparison to the nation and other states. The information in this section is excerpted from the *BLS Handbook of Methods*, produced by the US Department of Labor, Bureau of Labor Statistics.

County Business Patterns

This report uses County Business Patterns data from the US Bureau of the Census from 1990-1995 to compare Pennsylvania to the nation and other states. The data is aggregated to Ben Franklin Partnership regions from county level data and to technology clusters from three digit Standard Industry Classification (SIC) Codes. For some SIC Codes where county level data was not disclosed, we used a weighting method to allocate the balance of the employment for that industry to a BFTC region. This allocation method is fairly accurate given the size of the BFTC regions. Establishment data generally does not suffer from this disclosure problem. Generally the figures presented are for employment only, because shares of employment, payroll and establishments are relatively consistent.

County Business Patterns counts establishments at the location at which operations are performed. It is not necessarily identical with a company or enterprise, which may consist of one or more establishments. Establishments are classified on the basis of its major activity and all data are included in that classification. In some cases, data is only provided at a broader industry level. For this reason, the sum of industry components may not equal the total shown.

CBP data is derived from universe files and are not subject to sampling errors. However, the data are subject to nonsampling errors, such as: inability to identify all

cases in the universe; definition and classification difficulties; differences in interpretation of questions; errors in recording or coding the data obtained; and estimation of employers who reported too late to be included in the tabulations and for records with missing or misreported data.

Department of Labor and Industry, ES202 database

The ES-202 program is a cooperative effort of the Pennsylvania Department of Labor and Industry and the Bureau of Labor Statistics (BLS) of the U.S. Department of Labor. The ES-202 program provides comprehensive coverage of employment and wage information for workers subject to State unemployment insurance (UI) laws and Federal workers covered by the Unemployment Compensation for Federal Employees (UCFE) program.

Comparing ES202 to County Business Patterns Data

Covered employment and wages data from the ES-202 program differ from employment data published in County Business Patterns (CBP) of the Bureau of the Census in the following major areas:

- (1) CBP data exclude administrative and auxiliary units from "operating" unit data at the 4-digit level and include these data at the industry division level only. ES-202 covered employment, on the other hand, includes data for these units at the 4-digit SIC level.
- (2) CBP excludes agricultural production workers and household workers, some of whom are included in ES-202 covered employment data. CBP also excludes government units, all of which are included in the ES-202 program.
- (3) Every 5 years, data are collected for all multi-units within the scope of business and economic censuses and included in the CBP for that year. Annual updates for the larger multi-units are obtained from the sample selected for the Report of Organization Survey, and data for nonsample multi-units are estimated. Annual updates for single units come from the Internal Revenue Service and the Social Security Administration. ES-202 covered employment and wages data, on the other hand, include data collected from all active units each quarter.