Mapping Manufacturing Supply Chains in Northwest Pennsylvania:

The Shale Energy and Rail/Transportation Equipment Sectors

REPORT PREPARED WITH SUPPORT FROM THE U.S. SMALL BUSINESS ADMINISTRATION AND THE NORTHWEST PENNSYLVANIA PARTNERSHIP FOR REGIONAL ECONOMIC PERFORMANCE

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EntreWorks Consulting and the Center for Regional Economic Competitiveness

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Executive Summary

According to many experts, America is in the midst of a manufacturing renaissance. Thanks to lower energy costs, rising production costs overseas, and a host of other factors, manufacturing in America is primed for rebirth as formerly off-shored operations "reshore" back to the U.S. and new production facilities take root across the country.

The jury is still out on the scale and scope of this manufacturing renaissance, but even the most optimistic scenarios do not suggest that rebuilding U.S. manufacturing capacities will be easy. Global competition is tough and getting tougher; "just showing up" is not enough. Success will only come to those companies and communities that do the hard work of grooming talent, building capacity, and nurturing innovative and efficient business ventures.

Recent research suggests that supply chain management is one of the most pressing challenges facing U.S. manufacturers. Surveys of manufacturers identify several key challenges, including

- *Weak collaboration and poor visibility within supply chains,*
- *A limited understanding of the total cost of ownership, and*
- *Absence of an overall synchronized plan for supply chain management.*

These factors have helped trigger growing interest in what many experts refer to as supply chain optimization, a process whereby firms develop a supply chain strategy that is closely aligned with overall corporate strategy and execute this strategy in a manner that will "improve the speed of delivery of the supply chain, improve collaboration, reduce risk, and decrease overall total cost."

In an effort to assist small businesses in better understanding global supply chains and their roles within them, the U.S. Small Business Administration sponsored the American Supplier Initiative as a part of a wider Federal Investing in Manufacturing Communities Partnership (IMCP). IMCP is a multi-agency series of initiatives designed to support the revitalization of manufacturing across the U.S. Via ASI, SBA provided funds to support the development of supply chain analyses of disrupted or at-risk regional manufacturing communities. .

As part of the ASI solicitation, EntreWorks Consulting and the Center for Regional Economic Competitiveness (CREC) were selected to lead a supply chain analysis for Northwest Pennsylvania. The target region includes eight counties: Clarion, Crawford, Erie, Forest, Lawrence, Mercer, Venango, and Warren. The region is an ideal candidate for this type of analysis. It is home to large base of manufacturing firms in a diverse mix of sectors. In addition, the region's various business support and economic development agencies have a long history of collaboration and partnership, and are thus well positioned to develop new and improved programs to help strengthen regional manufacturing supply chains.

This analysis examines supply chain issues and opportunities in two broad industrial sectors: rail and transportation equipment manufacturing, and manufacturing opportunities related to development and use of shale gas. These two target sectors were selected for several reasons. In the case of rail and

transportation equipment manufacturing, Northwest Pennsylvania has long been a global leader. It is home to several major manufacturers, including GE Transportation and Brookville Equipment, and hundreds of suppliers and subcontractors. While rail manufacturing has been a local economic engine for more than a century, the industry is now facing major upheavals. Subcontractors and smaller suppliers need to understand and identify where new rail manufacturing-related market opportunities exist and while also assessing potential opportunities to diversify into new or related markets.

In the case of shale gas-related manufacturing, Northwest Pennsylvania sits in an advantageous position at the juncture of the Marcellus and Utica Shale formations which are among the world's richest sources of shale gas. The shale gas and oil revolution is widely considered to be a "game changer," that will help to transform American manufacturing. These impacts are expected to be global and national in scope, as reduced energy costs will ripple across all manufacturing sectors. This analysis assesses the local potential to benefit from proximity to shale gas resources. Further details on each sector are highlighted below:

Shale Energy and Manufacturing

The emergence of shale gas in the Marcellus and Utica Shale basins is likely the most exciting, and controversial, economic force driving Pennsylvania's economy for many years. Thanks to the development of shale gas, Pennsylvania ranks among the top states in oil and gas-related development. Between 2009 and 2012, the Commonwealth saw a nearly 260 percent jump in oil and gas-related jobs, placing Pennsylvania second in the U.S. for such job growth. To date, this activity has centered in other regions of the state, but is now moving into Northwest Pennsylvania.

As the industry develops and matures, new opportunities are emerging. In addition to direct benefits from drilling, shale gas resources will help to stimulate new industries, such as transportation, logistics, and manufacturing, that have less direct impacts to gas drilling and exploration. These midstream and downstream sectors will enjoy great opportunities to benefit from proximity to cheap and stable supplies of natural gas. The region's large manufacturers, and a diverse array of smaller suppliers, should develop new tools and approaches to capture these opportunities.

Increased demand in midstream and downstream markets will not only create opportunities for the companies directly involved in transporting and distributing oil and gas products. It will also generate work in the construction trades as it will require many builders and welders to put the necessary infrastructure. Oil and gas activities will also create indirect opportunities for producers of manufactured goods like pumps, piping, valves and sensors. However, taking advantage of these opportunities is not simple or straight forward.

For companies working in the oil and gas industry, quality is paramount. In fact, it is a far more important consideration than cost. The activities associated with oil and gas exploration, extraction, and distribution require a great deal of precision. The oil and gas industries provide real opportunities for local sourcing, but suppliers must adhere to high standards of responsiveness, quality, safety and fiscal solvency.

- *Quality is paramount consideration and far more important than cost. Many suppliers invest in industry certification programs like ISO 9001 or the American Petroleum Institute as a way to demonstrate their product quality.*
- *Firms involved in the oil and gas industry must also demonstrate impeccable safety records, given that few industries are as scrutinized about health, environmental and safety standards.*
- *Vendors must be available 24/7 to meet client needs. Beyond short-term responsiveness, firms must be able to deliver on actual deadlines as well as their forecast planning.*
- *Financial solvency is an important consideration because payments to vendors do not turn around as quickly as in other industries.*

Rail and Transportation Equipment Manufacturing

Northwest Pennsylvania and Erie in particular, are historical centers of the rail manufacturing industry. In fact, the industry here is 103 times more concentrated than elsewhere in the U.S., meaning that the sector is a huge driver of jobs and prosperity in the region. Our research identified 825 regional businesses specializing in rail and transportation equipment manufacturing. While rail has a strong history here, new challenges for the industry are emerging. How can suppliers respond to recent cutbacks in the region? How can regional leaders best help local firms capture new opportunities in the rail and transportation equipment manufacturing sectors?

Northwest Pennsylvania's greatest asset is the strong manufacturing base that already exists here. The region is home to hundreds of firms with key manufacturing skills, talents, and technological capacities. Large firms like GE Transportation and Brookville are well known, but the region is also home to hundreds of smaller suppliers who serve these large firms and other customers. The regional challenge is to build on this legacy by helping area firms compete in new and emerging markets, in both rail-related industries and elsewhere.

Our study highlighted a few sectors where local production capacities are limited. These include markets such as propulsion, electronics, and plate work among others. Addressing these supply gaps makes sense. But, more generally, community and business leaders need to aggressively promote the industry and identify new markets, both here at home and overseas, for local suppliers. Market projections suggest major future growth in both freight and passenger rail. Northwest Pennsylvania can capitalize on these opportunities for supporting local manufacturers and by investing in essential rail infrastructure.

Conclusions and Recommendations

Trends in these two broad industry sectors are generating exciting potential opportunities. However, at this point, it is best to speak of "potential" opportunities as opposed to "sure things." Many of the critical fundamentals are in place, but local leaders, corporate executives, and local manufacturers must act aggressively to build on this potential. Below, we offer recommendations that can help build a stronger base for manufacturing across Northwest Pennsylvania.

*1) **Support Development of Essential Infrastructure**: Rail transportation and shale gas developments can advance hand-in-hand. Much of the current growing demand for freight rail is driven by growing use of rail as a means to transport shale oil and gas. Continued investment in regional rail infrastructure can help support further industry growth by increasing demand for new rail cars and equipment, expanding broader demand for freight rail, and by reducing transportation costs for local manufacturers.*

*2) **Tap Critical Federal and State Funding Streams:** As the movement to promote the reshoring of manufacturing gains momentum, we can expect increased investments from federal, state, and local governments. Regional leaders must position themselves to compete for and win existing and new investment opportunities. Through partnerships like the NW PA PREP initiative, Destination Erie, and the Make It in America workforce development program, key regional partners already have a good track record of securing outside investments. Continued focus on this important work is needed. In addition to support regional economic and workforce development programs, regional leaders should also aggressively tap into outside funds that can help spur further development in key manufacturing sectors such as rail and transportation and in sectors related to shale gas development.*

*3) **Build on Key Cluster Strengths at the Regional and Local Levels:** Despite the importance of these manufacturing sectors, few communities across the U.S. are formally targeting the rail manufacturing or shale gas sectors as parts of their regional economic development strategies. In recent years, several regions and states have begun more concerted efforts to focus public attention and resources on these sectors. For example, the Marcellus Shale Coalition (Pennsylvania) and the Ohio Oil and Gas Association have emerged as strong advocates in the shale gas sector. Few regions actively promote rail manufacturing as a target industry.*

In an effort to further spur growth in key manufacturing sectors, regional and local economic development agencies should support the development of regional networks to support and advocate for these industries. These initiatives can take the form of new networks focused on rail and transportation manufacturing (such as Long Island's LIFT) or could be connected to existing networks for small and medium-sized manufacturers, such as NW PA PREP or the regional IRC networks.

*4) **Enhance Overall Business Support Service Capacity:** While many local manufacturers face challenges unique to operating in either the rail/transportation or shale-gas sectors, many of their growth challenges result from other less-industry-specific factors. Like entrepreneurs in other sectors, manufacturers need access to sophisticated consulting and business support tools.*

Thus, these regional networks need to do a better job of linking local manufacturers to high-quality business development support, technical support from university researchers, and to a range of outside investment options. In some cases, firms within these manufacturing sectors should be connected to existing and new NIST MEP Center programs such as ExporTech or supply chain optimization. Connections to financing are also crucial. Firms entering new rail markets will need outside investment to purchase new equipment, provide necessary training, obtain needed certifications and the like. Without new infusions of working capital, their ability to retool could be hampered.

***5) Embrace Excellence across Supply Chains**: These manufacturing sectors offer real opportunities for local sourcing, but only if local suppliers adhere to high standards of responsiveness, quality, safety, and fiscal stability. Being local is not enough. Vendors must embrace quality and excellence if they hope to develop new and profitable supply chain connections.*

Small business support to help manufacturers achieve industry recognized certifications could bring real benefits to many local firms. For small firms, engaging with larger OEMs typically requires compliance with industry recognized standards. Obtaining these certifications and registrations can be cost prohibitive, and create a serious barrier to small companies seeking to capture new supply chain opportunities. Assistance and funding support to pursue certifications may help local firms compete in these new markets.

Introduction: -An American Manufacturing Renaissance? Is it for Real?
-Will the Renaissance come to Northwest Pennsylvania?

If you read the business press over the past year or so, you would have a pretty good feeling about the state of manufacturing in America. It seems like a new report touting America's manufacturing renaissance, revival, rebirth, or revolution (take your pick for descriptions) comes out nearly every day from business consultants, academic researchers, and government agencies.[1]

There are many valid reasons for optimism. Operating costs in the U.S. are declining in comparison to other global competitors. The combination of lower cost energy in the U.S. and rising costs and uncertainty in overseas locations, such as China, are making U.S. locations very competitive as sites for new or expanded manufacturing facilities and operations. At the same time, many American manufacturers have embraced the last management thinking and practices, becoming global leaders in terms of innovation, efficiency and productivity.

Nonetheless, these promising trends are no guarantee of long-term success or prosperity. American manufacturers must recover from years of challenges and downsizing. A more skilled and talented workforce is needed, and a rebuilding of the "industrial commons" is required.[2] Along the way, American manufacturers—large, medium, and small firms---must commit to developing more resilient and more competitive supply chains. This will mean the reshoring of manufacturing jobs back to the U.S. after years of shifting production work overseas. It will also require the introduction or expansion of new practices such as:

- Emphasizing productivity and profitability by reviewing systems and processes, reducing costs and improving efficiencies.
- Improving lean-manufacturing skills to lower costs and improve quality.
- Partnering with local educational institutions to support development of courses and apprenticeship programs needed to address local talent needs and gaps.
- Collaborating with engineers in the early design stage of product development to optimize the product, lowering costs and improving time-to-market.
- Embracing new technology and methods that improve productivity and profitability.[3]

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[1] See, for example, Harold Sirkin, Justin Rose, and Michael ZInser, "The U.S. Manufacturing Renaissance," Boston Consulting Group, November 2012; McKinsey Global Institute, "Manufacturing the Future: The Next Era of Global Growth and Innovation, November 2012;PriceWaterhouse Coopers, "A Homecoming for U.S. Manufacturers? Why a Resurgence in U.S. Manufacturing may be the Next Big Bet," September 2012.

[2] For background, see the work of the MIT Project on Production in the Innovation Economy at http://web.mit.edu/pie/index.html.

[3] Frank Russo, It's Time to Rebuild the US Supply Chain Network,"*Industry Week,* April 29, 2014.

Smaller firms and new market entrants will need to showcase their capabilities. Larger firms and buyers must be able to easily access qualified American supply chain partners with the capabilities to meet production requirements and time-to-market guidelines.

A recent U.S. National Institute of Standards and Technology-Manufacturing Extension Partnership (NIST-MEP)-backed study offers strong evidence that effective supply chain management remains a big challenge for American manufacturers.[4] The analysis surveyed manufacturers to identify some of their critical supply chain-related needs. A number of key challenges were identified, with top priority given to the following items:

- Companies suffer from a lack of collaboration and visibility within supply chains,
- They have a limited understanding of the total cost of ownership, and
- They lack an overall synchronized plan for supply chain management.

These factors have helped trigger growing interest in what many experts refer to as supply chain optimization, a process whereby firms develop a supply chain strategy that is closely aligned with overall corporate strategy and execute this strategy in a manner that will "improve the speed of delivery of the supply chain, improve collaboration, reduce risk, and decrease overall total cost."[5]

This interest in occurring at the local, state, and federal levels. Across the U.S., many regions and states are engaged in new initiatives tied to reshoring and supply chain optimization. In Pennsylvania, the statewide PA Made Network, led by the state's Industrial Resource Center Network, is promoting a host of efforts to support reshoring initiatives. At the Federal level, the Obama Administration has supported and promoted the Investing in Manufacturing Communities Partnership (IMCP), a multi-agency series of initiatives designed to support the revitalization of manufacturing across the U.S.

Within the IMCP participating agencies, several partners have placed great emphasis on promoting supply chain optimization. The NIST-MEP program has developed its own supply chain optimization training programs and has also sought to support supply chain resilience via its Supplier Scouting programs.[6] The U.S. Small Business Administration (SBA) has supported IMCP goals via its American Supplier Initiative (ASI), a federal government-wide initiative designed to strengthen, build capacity and increase opportunities in America's supply chains for small businesses. Via ASI, SBA provided funds to support the development of supply chain analyses of disrupted or at-risk regional manufacturing communities. These research efforts are also designed to provide guidance that enables regional manufacturing communities to align resources and increase small business participation.

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[4] GENEDGE Alliance, "U.S. Supply Chain Competitiveness: How Agility, Planning, Collaborative Product Development and Supplier Alignment/Sourcing Execution are the Keys to Profitable Growth," Report prepared for NIST-MEP, February 2012. Available at: https://www.genedge.org/wp-content/uploads/2013/03/NIST-TCAR-SCM-Services-VOC-Report-2-2-12.pdf.

[5] See more at: http://www.scmep.org/supply-chain-optimization/#sthash.znuYZ2ir.dpuf.

[6] To learn more about Supplier Scouting, visit http://nist.gov/mep/scouting.cfm.

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This analysis examines supply chain issues and opportunities in two broad industrial sectors: rail and transportation equipment manufacturing, and manufacturing opportunities related to development and use of shale gas. These two target sectors were selected for several reasons. In the case of rail and transportation equipment manufacturing, Northwest Pennsylvania has long been a global leader. It is home to several major manufacturers, including GE Transportation and Brookville Equipment, and hundreds of suppliers and subcontractors. While rail manufacturing has been a local economic engine for more than a century, the industry is now facing major upheavals. GE Rail has been reducing its local presence in recent years, and, across the industry, competition for future contracts is becoming more fierce every day. Subcontractors and smaller suppliers need to understand and identify where new rail manufacturing-related market opportunities exist and while also assessing potential opportunities to diversify into new or related markets.

In the case of shale gas-related manufacturing, Northwest Pennsylvania sits in an advantageous position at the juncture of the Marcellus and Utica Shale formations which are among the world's richest sources of shale gas. The shale gas and oil revolution is widely considered to be a "game changer," that will help to transform American manufacturing. These impacts are expected to global and national in scope, as reduced energy costs will ripple across all manufacturing sectors.[7] This analysis assesses the local potential to benefit from proximity to shale gas resources. Some of these opportunities may be directly related to drilling and extraction, but more long-term and more promising prospects are likely to be found in mid-stream activities, such as transportation, storage and distribution, and in diverse mix of downstream activities. These downstream markets are less well understood but offer massive potential. For example, the American Chemistry Council projects that reduced energy costs will trigger more than $71 billion in new chemical industry-related capital investment between now and 2020.[8] Similar large-scale impacts are expected across other energy intensive manufacturing sectors, many of which are concentrated in Northwest Pennsylvania.

This report contains several sections. It begins with a general introduction to the Northwest Pennsylvania economy with a particular focus on the region's manufacturing assets, challenges, and opportunities. The report next provides in-depth analyses of the regional manufacturing supply chains related to shale gas development and the rail and transportation equipment manufacturing sectors.

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[7] T. Houser and S. Mohan, *Fueling Up: The Economic Implications of America's Oil and Gas Boom.* (Washington, DC: Peterson Institute for International Economics, 2014).

[8] American Chemistry Council, "Shale Gas, Competitiveness, and New U.S. Chemical Industry Investment: An Analysis Based on Announced Projects, May 2013. Available at: http://chemistrytoenergy.com/sites/chemistrytoenergy.com/files/shale-gas-full-study.pdf

Both supply chain analyses address a similar set of key issues. They provide a basic introduction to the industry, and then turn to analyzing the industry's operations in Northwest Pennsylvania. They then provide a value chain analysis for the industry, and identify key businesses in the regional market. The analysis concludes with a review of key issues, and industry opportunities. After these two industry case studies, the report concludes with recommendations for local businesses and for community and economic development leaders seeking to provide effective support for the region's manufacturing supply chain.

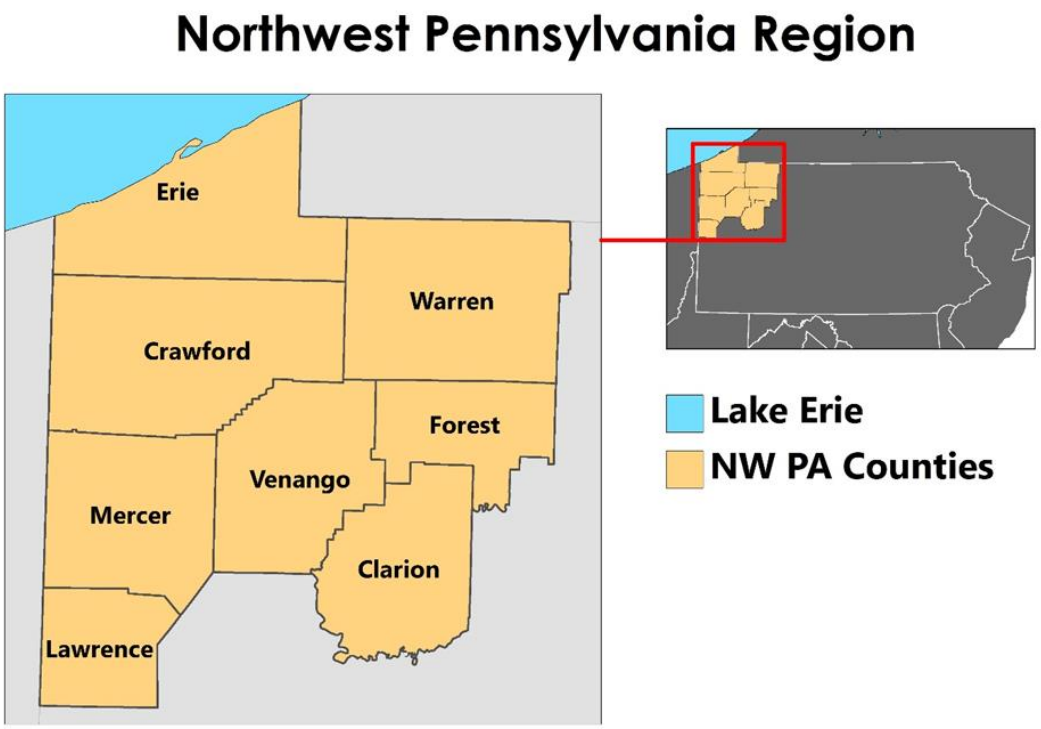
The Northwest Pennsylvania Economy

This project and research is focused on an eight county region of Northwest Pennsylvania and includes the following eight counties: Clarion, Crawford, Erie, Forest, Lawrence, Mercer, Venango, and Warren. The communities have a long shared history along with an extensive track record of regional cooperation.[9] The eight counties constitute Pennsylvania's NW PA PREP Region, one of ten state economic development regions under the Commonwealth's Partnerships for Regional Economic Performance program; this effort is overseen by the Northwest Pennsylvania Regional Planning and Development Commission (Northwest Commission), a federal designated Local Development District. NW PA PREP, which is serving as a lead local partner on this project, seeks to enhance the quality of services being offered to businesses in the state and engage a variety of partners in delivering economic and business development services in a more efficient and seamless way.

In this region, NW PA PREP includes a mix of partners from across the region, with a core state funded group composed of the Local Development District (the Northwest Pennsylvania Regional Planning and Development Commission), local Small Business Development Center offices (located at Duquesne University, Clarion University, and Gannon University), local Industrial Resource Center offices (Catalyst Connection and the Northwest Pennsylvania Industrial Resource Center), the Northwest Pennsylvania Incubator Association, and local county level economic development organizations. This latter group includes the following partners: the Clarion County Economic Development Corporation, the Economic Progress Alliance of Crawford County, Develop Erie, Forest County Community and Economic Development, the Lawrence County Economic Development Corporation, the Oil Region Alliance of Business, Industry and Tourism, the Penn Northwest Development Corporation, and the Warren County Chamber of Business and Industry. In addition to these partners who receive formal PREP funding from PA DCED, a number of other regional partners participate in PREP but are not funded by the state. The "unfunded" partners include groups like the Ben Franklin Partnership of Northern and Central Pennsylvania, the Northwest Regional Office of the Governor's Action Team (GAT) and PA DCED, the Pennsylvania Technical Assistance Program (PennTAP), as well as the Northwest Workforce Investment Board and the West Central Job Partnership.

[9] For background, see the Northwest Pennsylvania Commission's most recent Comprehensive Economic Development Strategy report at http://northwestpa.org/wp-content/uploads/2013/03/NW-CEDS-STRAGEGY-REPORT-6-10-09.pdf.

Figure 1: Project Region in Northwest Pennsylvania



NW PA PREP and other regional entities serve as evidence that the various local government entities in NW PA are committed to regionalism and to partnerships that help build a more competitive regional economy. Via NW PA PREP, the region's business service providers are working to improve the range of quality of services they provide to area small businesses. Via the region's IRC programs and other specialized initiatives, such as the Make It in America initiative, local partners are actively engaged in efforts to help spur local manufacturing and to promote the reshoring of manufacturing jobs.

This dual focus on small business development and manufacturing makes sense as these sectors are key drivers of the regional economy. According to the Census Bureau, there are about 16,300 establishments with about 272,000 employees in the Census registry of local companies. Most of these firms are quite small. As Figure 2 shows, about 70 percent of these establishments have fewer than 10 employees.

For some time, the region faced challenges in its efforts to spur small business growth. The NW PREP region added establishments at a slower rate than Pennsylvania and the US between 2000 and 2009. However in recent years, this record has improved. During the 2009-2010 period, the NW PREP region added more net new companies than during the entire period from 2000 to 2009.[10] Of course, the earlier period included a major recession that caused many companies to go out of business; however, the upsurge in new company formation is quite promising for the region.

[10] Data from Youreconomy.org.

Figure 2: Northwest Pennsylvania Establishments, By Firm Size

NW Pennsylvania Establishments by Broad Industry Sectors and Firm Size (2010)

Industry Description	1 to 9 employees	10 to 99 employees	100 to 499 employees	500+ employees	Grand Total
Retail trade	1,717	852	53	1	**2,623**
Personal svc (other srvc)	1,804	344	2	-	**2,150**
Health care & social assistance	1,324	708	100	12	**2,144**
Accommodation & food srvc.	914	673	6	-	**1,593**
Construction	1,165	206	8	-	**1,379**
Manufacturing	584	576	96	5	**1,261**
Professional, scientific, & technical srvc.	819	163	2	1	**985**
Finance & insurance	655	167	9	1	**832**
Wholesale trade	479	202	7	-	**688**
Admin & support & waste mgmt. & remediation srvc.	493	134	27	1	**655**
Transportation & warehousing	318	147	10	1	**476**
Real estate & rental & leasing	359	40	1	-	**400**
Arts, entertainment, & recreation	210	68	6	1	**285**
Information	194	65	5	-	**264**
Educational srvc.	94	82	5	6	**187**
Mining, quarrying, & oil & gas extraction	100	37	1	-	**138**
Utilities	48	28	2	-	**78**
Mgt. of companies & enterprises	32	32	3	-	**67**
Agriculture, forestry, fishing & hunting	48	2	-	-	**50**
Industries not classified	23	-	-	-	**23**
Total	***11,380***	***4,526***	***343***	***29***	***16,278***

Source: U.S Census Bureau, County Business Patterns 2010

The region's focus on manufacturing stems from its long history as a manufacturing center. Northwest Pennsylvania has been a major national and global industrial center since the late 1800s. In addition to major manufacturing activities, the region was the birthplace of the modern oil industry as it is home to Edwin Drake's first oil well—drilled near Titusville in 1859.

This manufacturing legacy lives on today, with manufacturing jobs accounting for roughly seventeen percent of local employment. As Table 2 shows, the region's concentration in manufacturing is significantly higher than elsewhere in Pennsylvania or in the U.S.[11] Manufacturing is the second largest sector in the region (behind health care), and manufacturing activity accounts for 23 percent of Gross Regional Product.[12]

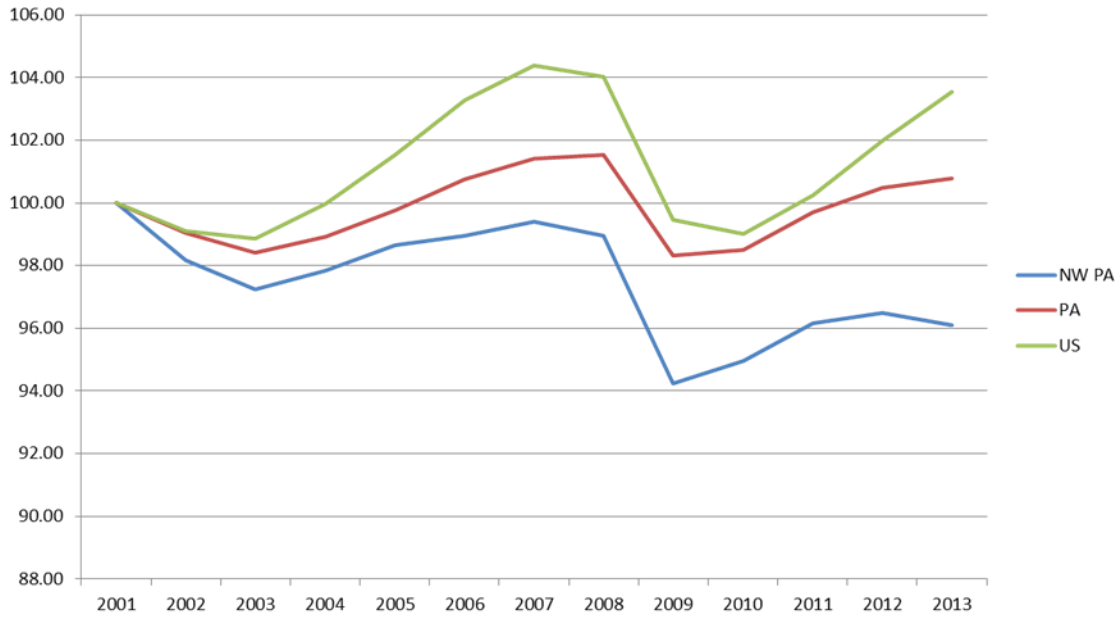
[11] Source: Economic Modeling Specials, Inc., Analysis by CREC.
[12] EMSI

Figure 3: Manufacturing's Impact, Region and Statewide

	Pennsylvania	NW PA
Manufacturing Jobs (2013)	566,991	50,461
MFG as a % of Total Employment	9.7%	**17.0%**
Avg. Annual Earnings (2013)	$73,092	$67,672
MFG Wages relative to Overall Avg. Wages	125.6%	**158.3%**

As Figure 4 shows, manufacturing jobs have been declining rapidly across NW PA, at a pace faster than statewide or national averages. Thus, sustained initiatives to help revitalize regional manufacturing and to identify new markets for local firms are greatly needed. This project is a key part of a host of regional initiatives focused on this important mission.

Figure 4: Manufacturing Jobs Performance, 2001-2013



The Northwest Pennsylvania Shale Gas Supply Chain

The emergence of shale gas in the Marcellus and Utica Shale basins is likely the most exciting, and controversial, economic force driving Pennsylvania's economy for many years. Thanks to the

development of shale gas, Pennsylvania ranks among the top states in oil and gas-related development. Between 2009 and 2012, the Commonwealth saw a nearly 260 percent jump in oil and gas-related jobs, placing Pennsylvania second in the U.S. for such job growth.[13] To date, most of this activity has occurred in Southwest and North-Central Pennsylvania, and in sectors directly related to oil and gas drilling and extraction.

As the industry develops and matures, new opportunities are emerging. New regions, such as Northwest Pennsylvania, will begin to see more direct benefits from shale gas development. More importantly, these new shale gas resources will help to stimulate new industries, such as transportation, logistics, and manufacturing, that have less direct impacts to gas drilling and exploration. These midstream and downstream sectors will enjoy great opportunities to benefit from proximity to cheap and stable supplies of natural gas. The region's large manufacturers, and a diverse array of smaller suppliers, should develop new tools and approaches to capture these opportunities.

This industry analysis is intended to help Northwest Pennsylvania's small business owners understand the structure of the region's oil and gas industry and how they might be able to plug into these supply chains. The report begins by providing important context about the oil and gas production and employment trends in the region and Pennsylvania overall. It then looks at the structure of the industry and shows the key components of the oil and gas supply chain as it relates to site preparation, drilling and extraction, midstream and downstream activities. It will also identify some of the key companies operating in these industries. Finally it provides some important background that companies need to understand if they seek to enter these supply chains.

Transformations in the U.S. oil and gas industry

Recent advances in oil and gas technology have transformed the US energy outlook. New technologies and processes developed in the Barnett Shale region in Texas (around the Fort Worth Basin) that began during the 1980s have changed the nature of oil and gas extraction. The process of hydraulic fracturing (commonly known as "fracking") was initially developed by Mitchell Energy in the 1980s.[14] Fracking involves injecting water, sand, and chemicals to help release gas from release from shale deposits. This process spurred a huge increase in Texas' "fracked" wells during the late 1990s.

In 2002, Devon Energy acquired Mitchell Energy and added a second technique—horizontal drilling—to the process. Unlike traditional vertical drilling techniques, horizontal drilling allows exploration of shale deposits beyond just the initial well. It also reduces the number of pipelines and wells needed to service a given deposit.[15] As a result, gas producers can extract more oil and gas from an individual well. Combined, these two techniques—horizontal drilling and hydraulic fracturing—have made the shale extraction process much more efficient and cost effective, and as a result commercially viable. These developments have the potential to totally change the landscape for U.S. energy usage. Since 2010, the

[13] http://www.bls.gov/opub/mlr/2014/article/the-marcellus-shale-gas-boom-in-pennsylvania.htm

[14] Houser, T. and Mohan, S. 2014. *Fueling Up: The Economic Implications of America's Oil and Gas Boom.* Peterson Institute for International Economics: Washington, D.C.

[15] Brown, J., Weber, J. and Wojan, T. November 2013. "Emerging Energy Industries and Rural Growth". USDA Economic Research Service, Economic Research Report Number 159.

U.S. has become the world's largest gas producer in the world. Moreover, the U.S. Energy Information Administration (EIA) forecasts that by 2040, 50 percent of the United States' natural gas supply will come from shale gas.[16]

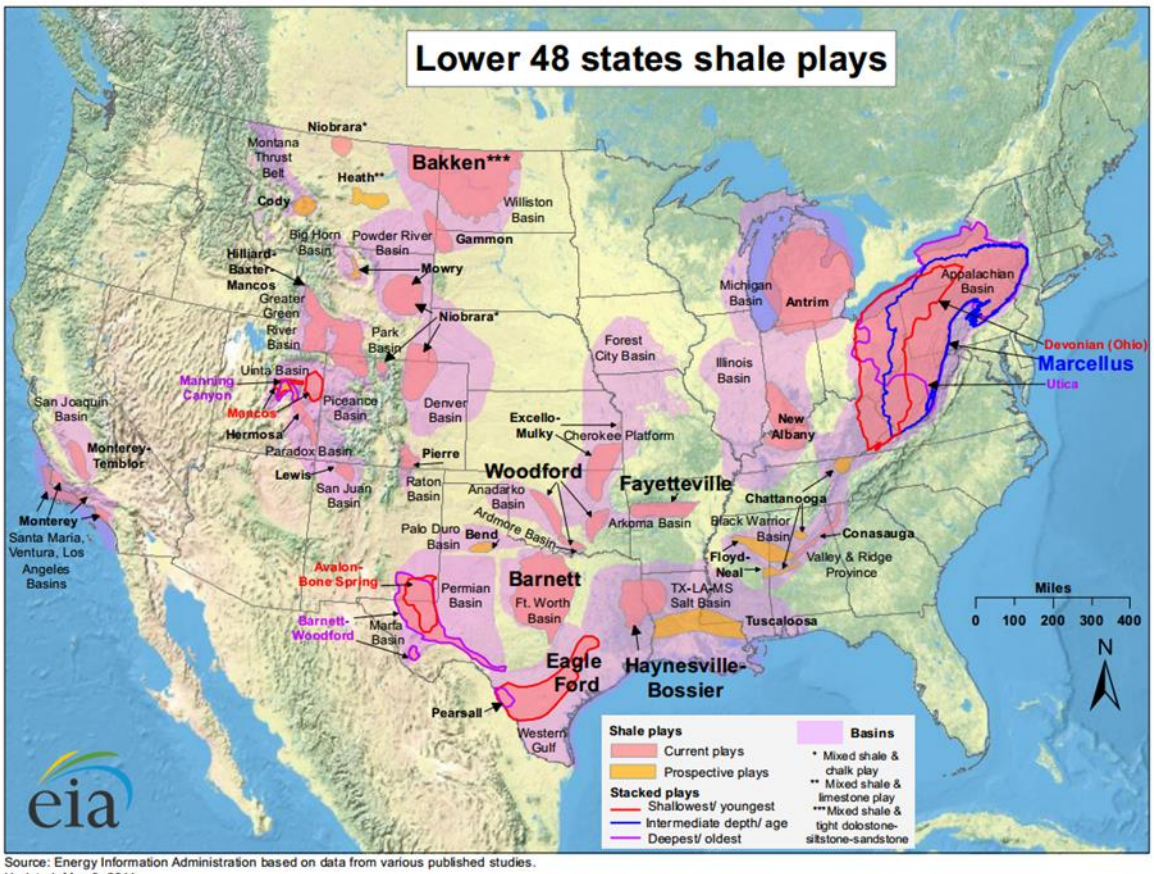
The impact of these natural gas developments can be quite significant for local economies. Drilling operations can boost output and create many high paying jobs, but they also lead to many indirect benefits as well. The multiplier effects generate opportunities for companies manufacturing drilling equipment and providing services to transport sand, water, and chemicals for example. Moreover, these activities can bring many new workers to what are often rural regions. This influx of new residents can therefore stimulate local housing, construction and retail activities. While these new residents help stimulate economic activity, they can also create challenges as schools, social service agencies, and law enforcement must cope with more intense demand for their services.

These shale developments began in Texas in the early 1990s and moved rapidly into Colorado and Wyoming in the early 2000s. Between 2000 and 2008 gross withdrawals of natural gas grew by 80 percent in Colorado and Wyoming. Other shale gas plays came online later in the decade. Development of the Fayetteville Shale resulted in a tripling of Arkansas' gas production between 2007 and 2010. Gas production in Louisiana (Haynesville Shale) and Pennsylvania (Marcellus Shale) also grew significantly between 2009 and 2010, with Pennsylvania doubling its production during that time.[17] Figure 5 shows a map of the United States' major shale plays.

[16] PriceWaterhouseCoopers. 2013. *Shale energy: A Potential Game-changer: Implications for the US Transportation and Logistics Industry*. Available at: http://www.pwc.com/en_US/us/industrial-products/publications/assets/pwc-shale-energy-transportation-logistics-impact.pdf

[17] Brown, J., Weber, J. and Wojan, T. November 2013. "Emerging Energy Industries and Rural Growth". USDA Economic Research Service, Economic Research Report Number 159.

Figure 5: Current Shale Plays in the Continental United States



Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

It is important to note that drilling activities are driven largely by the price of natural gas. The recent mid-2000's expansion of drilling emerged in a market where gas prices were relatively high and oil prices were declining.[18] Declining natural gas prices, driven by increased supply, have influenced the geographic distribution of drilling activities, pushing drillers from gas-rich plays to "tight oil" plays. Tight oil plays use the same technologies (hydraulic fracturing and horizontal drilling) to extract both oil and gas from deep shale deposits. When the price of natural gas drops gas-rich wells may be uneconomical. By contrast the ability to produce both gas and oil can make tight oil plays economical even when gas prices are low.[19] Major tight oil plays can be found in North Dakota's Bakken play and Texas's Eagle Ford play. The Utica Shale, which lies beneath Ohio and Pennsylvania, is a promising tight oil play that oil co s important to note that drilling activities are driven largely by the price of natural gas. The recent mid-2000's expansion of drilling emerged in a market where gas prices were relatively high and oil prices were declining.[20] Declining natural gas prices, driven by increased supply, have influenced the geographic distribution of drilling activities, pushing drillers from gas-rich plays to "tight oil" plays. Tight

[18] Brown, J., Weber, J. and Wojan, T.. "Emerging Energy Industries and Rural Growth." U.S. Department of Agriculture Economic Research Service, Economic Research Report Number 159, November 2013.
[19] See Houser and Mohan, especially pp. 15-35.
[20] Brown, Weber and Wojan.

oil plays use the same technologies (hydraulic fracturing and horizontal drilling) to extract both oil and gas from deep shale deposits. When the price of natural gas drops gas-rich wells may be uneconomical. By contrast the ability to produce both gas and oil can make tight oil plays economical even when gas prices are low.[21] Major tight oil plays can be found in North Dakota's Bakken play and Texas's Eagle Ford play. The Utica Shale, which lies beneath Ohio and Pennsylvania, is a promising tight oil play that oil companies are beginning to explore. mpanies are beginning to explore.

Within the Marcellus region, reduced natural gas prices have caused a shift of focus from "dry gas" fields (natural gas only), located in the eastern Marcellus Shale to "wet gas" fields (which produce both oil and natural gas) in the western part of the region.[22] Northwest Pennsylvania—defined here as the eight county region covering Clarion, Crawford, Erie, Forest, Lawrence, Mercer, Venango, Warren counties—is advantageously located because it sits on top of both the Marcellus and Utica Shale. Therefore, it is well positioned to take advantage of the ongoing natural gas activities in the Marcellus Shale, and also Utica Shale's natural gas and tight oil reserves. Moreover, the region is just north of Beaver County where Shell Oil will be constructing the first ethane cracker facility in the Eastern United States. This project, strongly backed by local and state officials, is still working through the permitting process, but when completed this facility will separate ethylene from the ethane extracted from oil and gas wells. Ethylene is a foundational component for a wide variety of plastics products, so this development could potentially open many new manufacturing opportunities.

[21] Houser and Mohan.

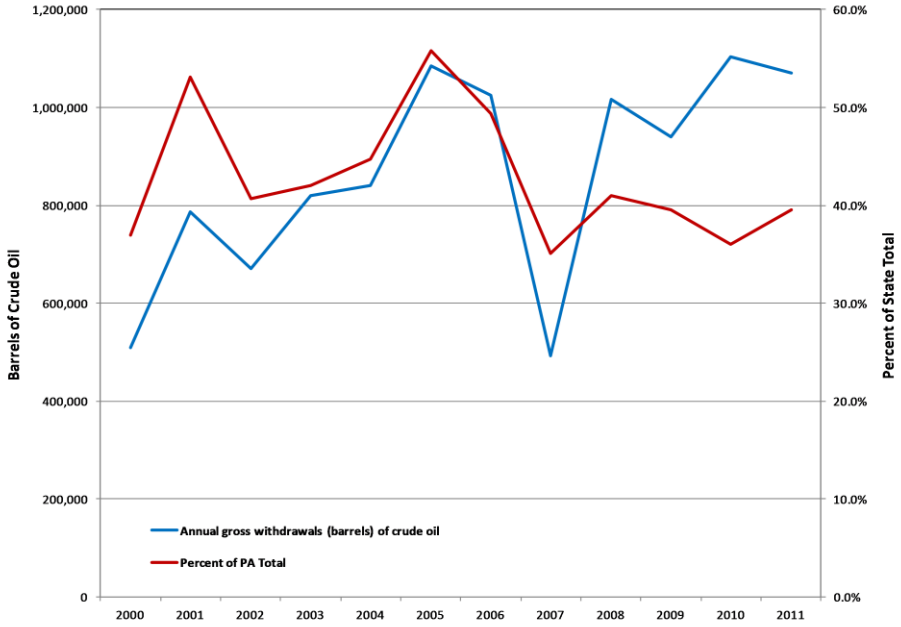
[22] Seydor, S. Clements, E., Pantelemonitis, S., Deshpande, V., et al. May 2012. "Understanding the Marcellus Shale Supply Chain." University of Pittsburgh, Joseph M. Katz Graduate School of Business. Available at: http://entrepreneur.pitt.edu/sites/default/files/PittUnderstandingtheMarcellusShaleSupplyChain.pdf

Overview of oil and gas activities in Northwest Pennsylvania

Northwest Pennsylvania has a long history with oil and gas. Local residents colloquially refer to the Oil City and Titusville area as "the valley that changed the world." The region was the country's first center for oil drilling and it continues to produce oil. According to data from the U.S. Department of Agriculture's Economic Research Service, there has been some fluctuation between 2000 and 2011, but, within the context of Pennsylvania, the region remains a significant oil producing region. As shown in Figure 6, the region has produced around a million barrels of oil annually between 2008 and 2011. In spite of the growth of production in places like Washington County, the eight counties of northwest Pennsylvania continue to account for almost 40 percent of the Pennsylvania's overall output of crude oil.

As noted above, the region is well positioned to take advantage of both the Marcellus Shale with its available natural and the larger and deeper Utica Shale that provides access to both oil and gas. The exploration and development of these shale plays has led to an increase in natural gas production over the past decade. Figure 7 shows that natural gas production was 50 percent greater in 2011, then it was in 2000. This is due in large part to Marcellus Shale developments particularly in Clarion and Crawford counties. In spite of this growth, the region has not experienced the explosive growth that has gone on elsewhere in the state such as the Northern Tier (Tioga, Bradford, Susquehanna and Lycoming) and

Figure 6: Oil production in northwest Pennsylvania, relative to the state (2000-2011)



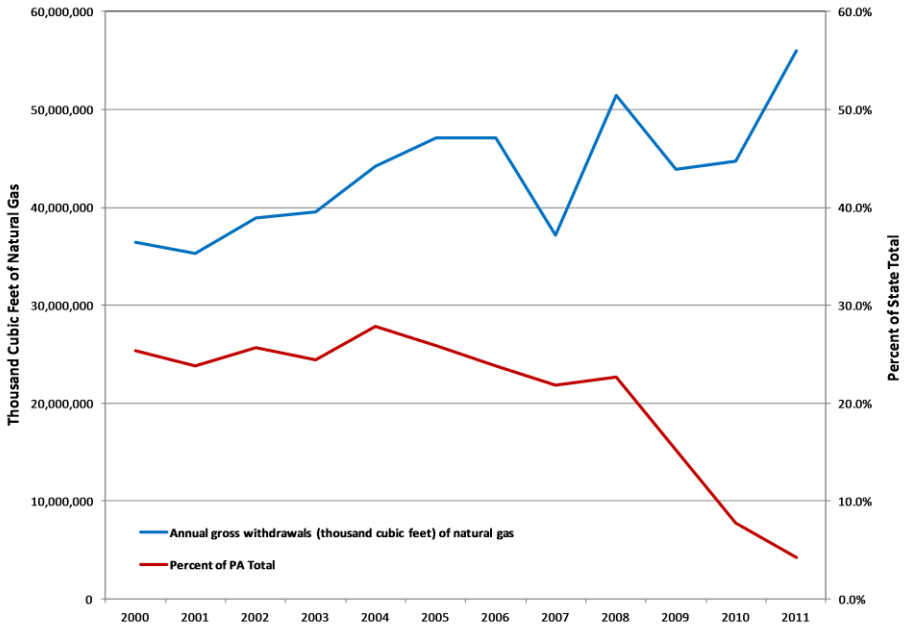
Source: US Dept. of Agriculture, Economic Research Service

southwest Pennsylvania (Washington and Greene). Figure 7 further illustrates that the natural gas drilling activity has been focused elsewhere in the state. Between 2000 and 2011, the region's share of

natural gas production (as measured in Thousand Cubic Feet of natural gas) has declined from 25 percent to 4 percent.

As will be shown later in this report, businesses do not necessarily need to be located within the center of drilling activities to be able to take advantage of oil and gas-related business opportunities. Much of the initial work on the Marcellus Shale was led by firms from Texas and Oklahoma, traditional centers for the energy industry. Over time, more Pennsylvania-based companies will participate in these

Figure 7: Natural gas production in northwest Pennsylvania, relative to the state (2000-2011)



Source: US Dept. of Agriculture, Economic Research Service

efforts. This shift is reflected in the employment data for oil and gas-related activities.

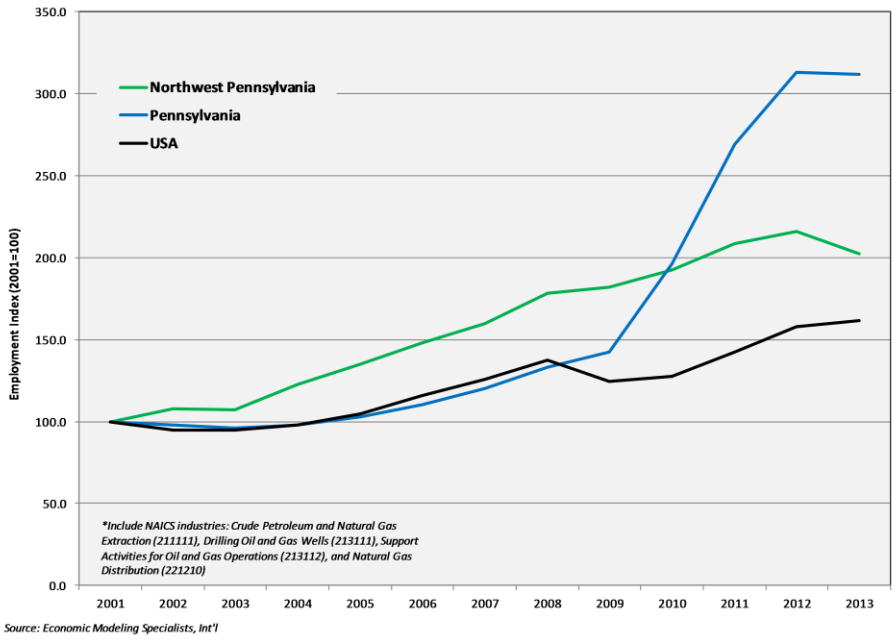
As with most natural resources development, these activities can lead to boom and bust cycles in the local economy. The development of a natural gas play can clearly lead to an economic boom during its early development phases. The demand for capital and labor to prepare the drilling locations and begin extraction can overwhelm what are often rural economies. After the drilling sites and infrastructure have been constructed, employment tends to plateau and then decline as it moves into a more mature production phase.[23] However, the bust cycles for natural gas production are not yet fully understood for several reasons. Many natural gas wells can be re-fracked, and this can maintain demand for companies involved in drilling and the support for these operations. More importantly, however, natural gas prices dictate the level of activity and ultimately this will determine the severity of the bust cycle associated with natural gas development. If prices increase, activity will increase and vice versa. This obviously has important consequences not only for the activities directly involved with natural gas development, but also for many of the indirect activities that benefit from them.

[23] Brown, Weber and Wojan.

As growth has exploded statewide, Northwest Pennsylvania's oil and gas employment has grown in a steadier manner since 2009. Figure 8 provides an index of employment in the region, Pennsylvania and the US for four key industries—crude petroleum and natural gas production, drilling oil and gas wells, support activities for oil and gas operations, and natural gas distribution. The index shows that oil and gas-related employment in Northwest Pennsylvania has consistently grown faster than US averages and, until 2009, it also grew faster than statewide averages. Combined, employment in these industries more than doubled between 2001 and 2013. However, due to the Marcellus Shale development in other regions like southwest Pennsylvania and the Northern Tier, industry employment within Pennsylvania has more than tripled during that same time period.

Overall, approximately 1,700 people work directly in the oil and gas industries of the eight counties of

Figure 8: Index of Oil and Gas-related employment (2001-2013)



Northwest Pennsylvania. Figure 9 shows the individual industries that have been driving this employment growth. Crude petroleum and natural gas extraction is the region's largest oil and gas-related industry with over 650 jobs, but support activities for oil and gas activities has been the fastest growing sector with over 400 net new jobs and an annual growth rate of 13.4 percent. This industry is now four and a half times as large as it was in 2001. While this local growth rate is impressive, it is outstripped by the massive overall statewide growth for oil and gas operations statewide. Today, the industry is 11 times larger than it was in 2001.

Figure 9: Employment in oil and gas-related industries

Industry	Northwest Pennsylvania				Pennsylvania			
	2001	2013	Change 01-13	% Annual Change	2001	2013	Change 01-13	% Annual Change
Crude Petroleum and Natural Gas Extraction	379	659	280	4.7%	1,746	4,925	3,179	9.0%
Drilling Oil and Gas Wells	44	137	93	9.9%	693	3,798	3,105	15.2%
Support Activities for Oil and Gas Operations	115	518	403	13.4%	1,083	11,815	10,732	22.0%
Natural Gas Distribution	301	382	81	2.0%	4,356	4,005	-351	-0.7%
Total	***839***	***1,696***	***857***	***6.0%***	***7,878***	***24,543***	***16,665***	***9.9%***

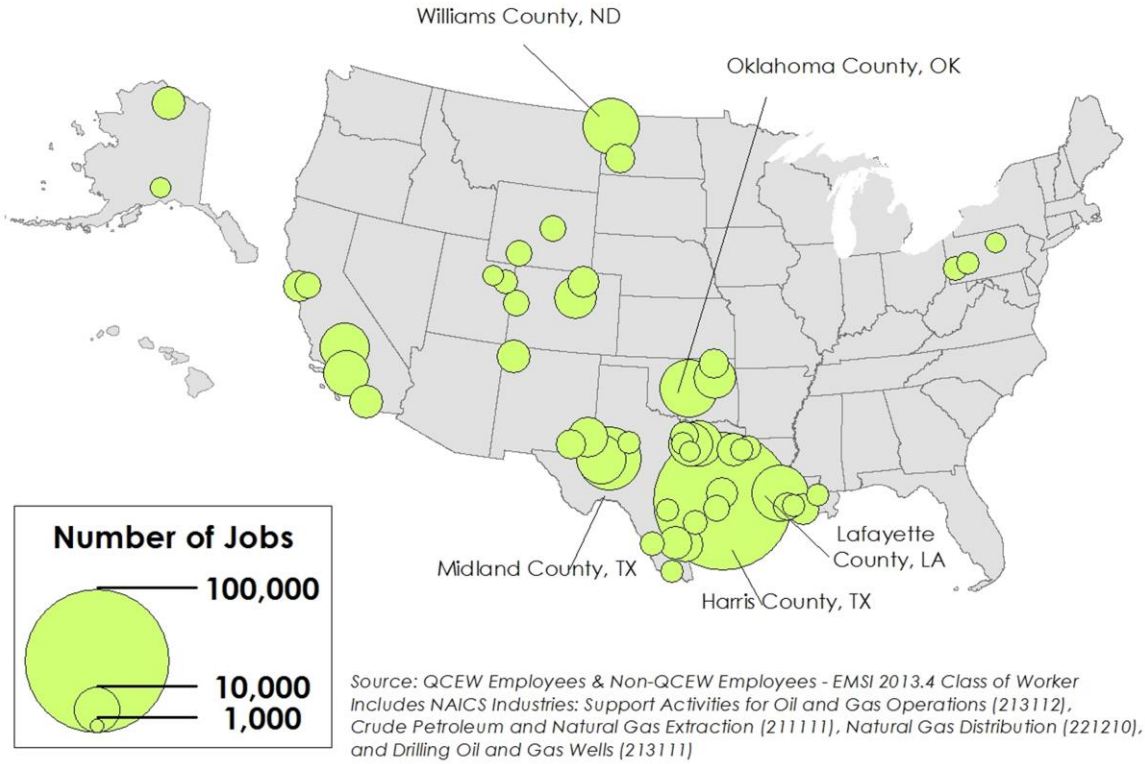
Despite Pennsylvania's rapid growth, the Commonwealth remains a small player in national and global markets. Figure 10 shows the fifty U.S. counties with the greatest amount of oil and gas-related employment. The majority of oil and gas employment can be found in more traditional oil states like Texas, Oklahoma and Louisiana. North Dakota and Colorado are also experiencing explosive growth around the development of the Bakken Play. Within Pennsylvania, only three counties make the top 50—Allegheny, Indiana and Lycoming. Understanding these trends are important for developing the region's oil and gas activities, because at the very least they indicate where significant market opportunities may exist. Namely, the overwhelming majority of these opportunities are located outside of Northwest Pennsylvania.

Direct and indirect employment in the oil and gas industry, however, is not the only way that the region's economy benefits from these activities. The multiplier effects of these activities can be felt in a wide variety of other economic sectors. For instance, the infusion of workers to relatively good paying jobs has helped stimulate Pennsylvania's retail establishments, restaurants, and hotels. Moreover, the growing demand for housing in some regions has helped boost the housing market.

However, in general, the real benefit from the natural gas development will not come in the form of new contracts or business with the shale gas industry. Rather, the cheaper energy will benefit both home owners and large energy users. Cheaper oil prices are especially important for cold weather states and regions that use greater amounts of oil to heat homes. Within the industrial economy, many manufacturers stand to benefit from lower energy costs. This is particularly true for energy intensive industries like chemicals, aluminum, glass and cement manufacturing. These lower costs may not only reduce their operating costs, but also encourage them to expand and invest in their current facilities.

These trends will generate local opportunities to take advantage of the oil and gas activity underway in the region. In order to do this, however, firms must understand where those opportunities are located and where they fit within the broader oil and gas industry supply chain. The next section will take a more in-depth look at the structure of the industry and will map out its supply chain.

Figure 10: Top 50 counties in Oil and Gas-related employment (2013)



Source: QCEW Employees & Non-QCEW Employees - EMSI 2013.4 Class of Worker Includes NAICS Industries: Support Activities for Oil and Gas Operations (213112), Crude Petroleum and Natural Gas Extraction (211111), Natural Gas Distribution (221210), and Drilling Oil and Gas Wells (213111)

Industry structure and value chain analysis for Northwest Pennsylvania

The basic supply chain for the Marcellus Shale development is described in a 2012 University of Pittsburgh Study—*Understanding the Marcellus Shale Supply Chain*.[24] This study identified ten components to the Marcellus Shale supply chain including:

- Exploration
- Leasing, acquisition and permitting
- Site construction
- Drilling
- Hydraulic Fracturing
- Extraction and production
- Transportation and processing
- Storage
- Distribution
- Marketing

For the purposes of this analysis, we have broken the Marcellus Shale supply chain into three primary components—site preparation, drilling and extraction, and midstream. Site preparation focuses on the exploration for potential drilling sites and the subsequent acquisition and leasing of that drilling and extraction phase involves the actual drilling of the well, the hydraulic fracturing required to free the oil and gas from the shale, and then the subsequent extraction and production of oil and gas. The midstream component of the supply chain centers on the transportation, storage and distribution of oil and gas.

Proximity to gas deposits and drilling locations can bring direct economic benefits. However, an increase in oil and gas drilling can also create increased demand for a variety of goods and services. The resulting direct and indirect impacts are geographically and sectorally uneven. We use this framework as a starting point for our analysis, and then attempt to connect these activities to specific industries. In doing so, we can gauge the nature and extent of these activities in Northwest Pennsylvania and how they compare relative to the rest of Pennsylvania and the US. We are specifically interested in the period from 2008 to 2013, as this is the period of time where the Marcellus Shale activity began to grow rapidly in Pennsylvania.

This section identifies industries involved in those broad supply chain areas.[25] These diagrams are based partly on information from other reports and stakeholder interviews. However, this information has been further supported by analyzing the inter-industry linkages of the core industries driving the oil and gas industry. In doing so, we can gain a better sense of the industries that are buying and selling from one another. The diagrams presented below show the value-chain relationships found in the three primary components of the Marcellus Shale development (site preparation, drilling and extraction, and

[24] Seydor, Clements, Pantelemonitis, and Deshpande.
[25] Industries are classified via their North American Industry Classification System (NAICS) Codes.

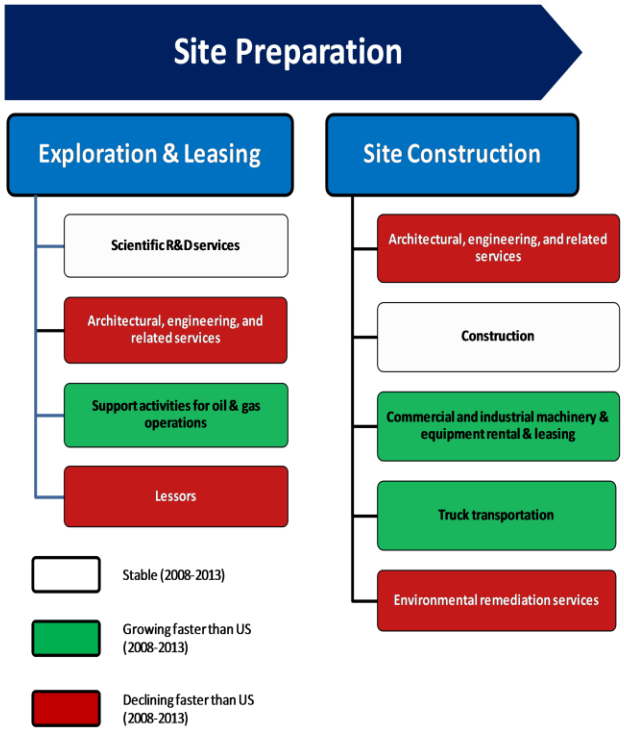
midstream). By considering the employment trends[26] for each of the industries found within the value chain, we can begin to identify areas of potential growth and regional advantage. The industry trends data are available in Appendix A.

Site Preparation

Figure 11 depicts the key industries associated with the site preparation phase of the Marcellus Shale development. Identifying potential sites often involves companies that fall within the research and development services in the physical sciences industry (NAICS 541712). This is a relatively small industry within the region, and these firms are generally headquartered elsewhere. Before drilling can begin, the drilling companies must obtain permission of the land owner. The leasing of land and mineral rights has created some business for local law firms, but this activity generates only a small number of local jobs. . There is also a significant amount of permitting involved, as the companies must comply with the state's environment regulations. Compliance can generate demand for land services like surveying and mapping to ensure, for instance, that the pad is a sufficient distance from watersheds and other factors related to completing environmental impact assessments.

Once the leasing agreements have been completed, the drilling company can begin to prepare the actual drilling site. This involves a significant amount of both engineering services and construction. While driven by a number of other industries and sources of demand, employment in the engineering services industry (NAICS 541330) has lost net employment in the region over the past five years whole

Figure 11: Industries associated with site preparation



[26] The industry trends analysis uses data developed by Economic Modeling Specialists International (www.economicmodeling.com).

experiencing modest gains throughout the state during the same period. However, it is important to note that this work is often undertaken by companies based outside of the state and the region and therefore this activity is not completely captured by these employment data.

Preparing the drilling site also leans heavily on the construction industry. Beyond actually building the drilling pad, there is a need to either build or upgrade roads in order to get to the drilling site. Similarly, construction companies are needed to dig mud ponds to hold the water and sediment from the drilling process, and install storage tanks for some of the chemicals and wastewater. In addition, sites require other features like fencing and temporary office buildings. Again the data here do not capture the specifics of construction activity due to the Marcellus Shale development. However, they do show that the construction industry (NAICS 23) declined at a slower rate in the region (-0.6 percent annually) and the state (-2.1 percent annually) between 2008 and 2013, than in the U.S. overall (-4.0 percent annually). We can presume that the demand created by the oil and gas industry partially explains why the region and the state did not decline as fast as the nation. The site preparation phase of the drilling process also creates demand for industries like commercial and industrial machinery and equipment rental and leasing (NAICS 5324). This industry has few employees in the region (less than 60 in 2013), but has grown substantially in Pennsylvania overall. Between 2008 and 2013, the industry grew from 3,800 jobs to over 6,700. This annual growth rate is 12 times faster than the industry's national growth rate during the same period.

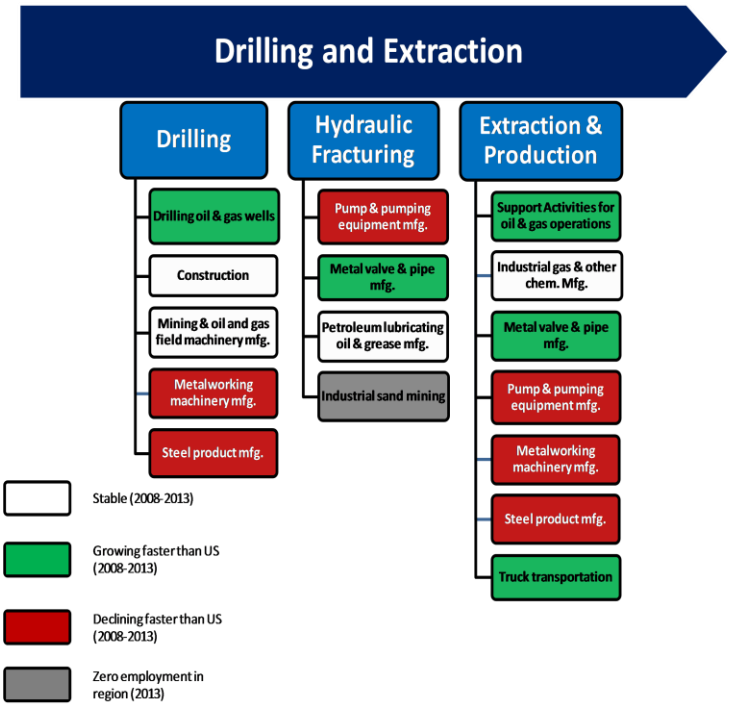
Perhaps the area where the Marcellus Shale development has created some of the greatest local opportunity is in the Truck Transportation industry (NAICS 484). Truck transportation is vital to all parts of the drilling process. It is needed to move rock and dirt during they site preparation phase, water and chemicals during the drilling phase, and then transporting the actual oil and gas to distribution and processing facilities. Again, much like the construction industry, trends in the truck transportation industry are not driven entirely by oil and gas. Nationwide, the truck transportation industry declined 0.4 percent nationally between 2008 and 2013. By contrast, the industry grew 1.7 percent annually in the region (3,600 jobs in 2008 to 4,000 jobs in 2013), and 1.8 percent annually in the state during the same period. Specialized Freight Trucking has been particularly noteworthy as it has added 163 net new jobs between 2008 and 2013. The need for trucking associated with the Marcellus Shale development most definitely spurred job growth in Pennsylvania.

Drilling and extraction

Figure 12 shows some of the industries associated with drilling and extraction part of the shale development process. Prominent industries in this segment of the process include drilling oil and gas wells (NAICS 211311), mining and oil and gas field equipment manufacturing (NAICS 33313), and construction (NAICS 23). Drilling oil and gas wells (NAICS 213111) was the industry that saw the fastest growth (12.2 percent annually over the past five years), in the region but it remains a relatively small source of employment. Between 2008 and 2013, drilling employment grew from 77 to 137 jobs. While not a large job generator for the region, it has been a big source of employment growth for Pennsylvania. Over the past five years, the drilling industry has created about 2,200 net new jobs within the state—this increase accounts for almost 80 percent of the net new employment for the industry nationwide.

The manufacturing of machinery used in mines and oil and gas fields (NAICS 33313) is an area of greater strength for the region. The region has almost 1,300 jobs in this industry, and those jobs account for a

Figure 12: Industries associated with drilling and extraction



third of its employment within the state of Pennsylvania. Several of the leading firms in this industry include MVS Saegertown and T. Bruce Campbell Construction. This industry is also relatively concentrated in the region, as its relative share of employment is 6.5 times greater in Northwest Pennsylvania than it does nationally. That said, it has experienced modest growth (0.8 percent annually) over the past five years, especially when compared to the industry's 4.2 percent annual growth nationwide during the same period. As oil and gas development activities grow in the U.S., this sector could offer great potential for Northwest Pennsylvania's smaller manufacturers.

Both the fracking and extraction process generate demand for other manufactured goods. For instance, the drilling and extraction phase make extensive use of pumps and pumping equipment, valves and pipes, and metalworking machinery (which includes cutting and machining tools). Two of the industries involved in manufacturing these products—metal valve and pipe manufacturing (NAICS 3329) and metal working machinery manufacturing (NAICS 3335) are highly concentrated in the region. However, their recent growth trajectories have differed over the past half-decade. The region's valve and pipe manufacturing industry—which employs almost 1,500 people in the region—grew one percent annually between 2008 and 2013, while the industry nationwide lost net employment. Among the larger regional companies involved in this industry include JM Eagle, Morris Coupling, and Vertical Seal. By contrast the region's metalworking machinery manufacturing industry—which accounts for 2,500 jobs regionally—lost employment at a faster rate (-3.5 percent annually) than the U.S. industry (-1.2 percent annually).

Several of the region's metal working machinery manufacturers include Pennsylvania Tool and Gages and Reynolds Services. The pumps and pumping equipment industry also lost employment, but has a relatively small regional presence (with only 80 local jobs).

Given that many of the industries involved in the drilling and extraction process use steel as a critical input, the steel industry benefits from growth in the oil and gas industry. The steel industry has lost employment in Northwest Pennsylvania over the past five years. Yet, it still employs almost 1,300 people and remains roughly ten times more concentrated in the region than in the US economy as a whole. The demand generated by the oil and gas industry for pumps, pipes, tanks, metalworking machinery, and many other steel dependent products has likely benefitted the steel industry even as it has suffered net job loss.

The drilling and extraction phase of the oil and gas supply chain also creates demand for other industries. For instance, companies in the industrial gas and other chemical manufacturing industry (NAICS 325188) are responsible for some of the fluids in the fracking process. The processes also rely upon the petroleum lubricating oil and grease manufacturing industry. In both instances, employment within Northwest Pennsylvania is minimal. Combined, both industries account for fewer than 100 jobs. The drilling and extraction process also requires ample supplies of 'frac sands'. Industrial sand is another key input in the fracking process, and the region has no industrial sand mining employment (NAICS 212322). Much of the frac sands come from Wisconsin where there the sand is the right material (quartz), shape and size, and the sand deposits are located near bulk transportation corridors such as barge and rail.[27]

Drilling is a very labor intensive process, and these workers help spur important ripple effects in the local economy. Additional workers create opportunities for hospitality, lodging, retail and other services. This is an important local benefit of the drilling activities, although the effect is often short-lived. This is due in part by the fact that most of the actual fracking activities are done by companies headquartered outside of the region. This is also highly specialized work and generally requires expert workers who come from other regions (often Texas). As noted earlier, however, the volume of these activities is driven significantly by the price of natural gas. If prices are high, it is more economically viable for the drilling companies to drill and operate more wells, or refrack existing wells. As a result, the rate of drilling and extraction fall off depends heavily on natural gas prices.

Midstream activities

Midstream activities are those that involve the transportation, storage and distribution of oil and gas products. These activities have typically supported the exploration and production companies, but the recent shale boom has created significant demand for midstream companies. For example, analysts estimate that 35 percent of the gas drawn from the Bakken shale play needs to be flared because of

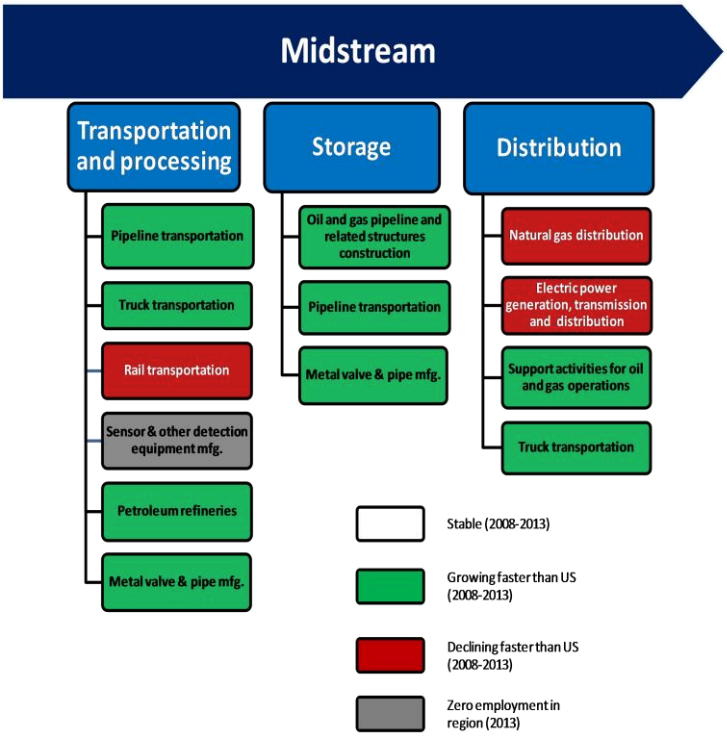
[27] Deller S. and Schreiber, A. May 2012. "Frac Sand Mining and Community Economic Development". University of Wisconsin-Madison Department of Agricultural & Applied Economics, Staff Paper No. 565. Available at: http://www.aae.wisc.edu/pubs/sps/pdf/stpap565.pdf

insufficient infrastructure to store or transport it.[28] As the domestic oil and gas industry develops, midstream companies can capture new markets to support these activities.

Figure 13 shows the industries associated with midstream activities. Truck transportation remains as primary method for moving oil and gas and it has experienced growth over the past five years. Pipeline transportation (NAICS 486) is another midstream opportunity. It is a small industry within the northwest Pennsylvania (160 jobs), but, between 2008 and 2013, its regional growth rate (3.3 percent) outpaced the state (0.2 percent) and the nation (1.9 percent). Local employment is entirely concentrated in natural gas pipelines. While still small in terms of total jobs, the local concentration of these jobs is quite high—the industry is 70 percent more concentrated in the region, than in the U.S. as a whole. Oil and gas related pipeline and related structures construction (NAICS 23712) jobs have also grown, but this remains a very small industry within the region as it accounts for roughly 50 jobs.

In addition to pipelines, much of the region's oil and gas is shipped by rail. Due in part to this increased demand CSX is making major investments in the region's rail infrastructure. The rail transportation industry (NAICS 482) currently accounts for about 450 jobs in the region, down from 520 jobs in 2008. It is also down in Pennsylvania, even though it has experienced modest growth nationwide during the same period. Nonetheless, freight rail is rightly viewed as a major future midstream opportunity. Rail terminals can be built relatively quickly compared to similar pipeline facilities. Moreover, rail can service every U.S. refinery and offer flexibility to the oil and gas industry as it shifts production between

Figure 13: Industries associated with midstream activities



[28] *The Rise of the Midstream.* The Deloitte Center for Energy Solutions. November 2013. Available at: https://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/Energy_us_er/us_er_RiseOfTheMidstream_Nov2013.pdf

different shale plays.[29] Within Northwest Pennsylvania, this opportunity also aligns well with region's historical strengths as a center for both rail transportation and rail-related manufacturing opportunities. As the second part of this report notes, the growth of rail offers many potential new markets for the region's small and medium-sized manufacturers.

Several other industries also merit mention. Natural gas distribution (NAICS 2212) has experienced net employment growth within both Pennsylvania and the U.S. between 2008 and 2013, but declined in the region. Natural gas distribution now accounts for about 380 jobs in the region, but it has lost almost 80 net jobs in the last five years. In spite of this, industry employment is still 60 percent more concentrated in the region than it is the U.S. economy overall. Further downstream, power plants that produce, transmit, and distribute electricity also lost employment between 2008 and 2013, but the region lost employment at a faster rate than either the state or the nation during this period.

Midstream activities also generate their own spin-off opportunities and spur new demand for jobs related to surveying, civil and environmental engineering and environmental assessments. They can also create jobs in construction and other trades like welding that are essential to the construction and maintenance of this equipment and infrastructure. They also spur demand for materials like steel and components like valves, pumps and sensors. As noted above, the region has some strength in valve manufacturing, but pump and pumping equipment manufacturing is small and declining. There is currently no regional employment in the sensors and other detection equipment manufacturing industry. All of these sectors could grow as local shale gas development increases.

Downstream opportunities

While these direct and midstream opportunities are generating jobs and local economic activity, the more sustained and long-term impacts are likely to be found in manufacturing activities that benefit from proximity to shale gas resources, and more generally from the emergence of cheaper energy inputs into a range of manufacturing industries. Northwest Pennsylvania is well-positioned to compete and prosper on both accounts as it has easy access to emerging shale gas resources and is also home to a large base of manufacturing industries, many of which can and will benefit from lower energy costs.

The chemical industry is among those expected to enjoy the greatest benefits from the shale gas revolution. In fact, in February 2014, new industry investment triggered by the shale gas revolution exceeded $100 billion, with more than 637,000 potential new jobs tied to these investments.[30] These effects are expected to ripple across the chemical industry value chain, and generate new market opportunities in dozens of related sectors such as plastics, coatings, tires, textiles, paints, and many more.[31]

[29] http://www.thefinancialist.com/the-pipeline-alternative-shale-by-rail/

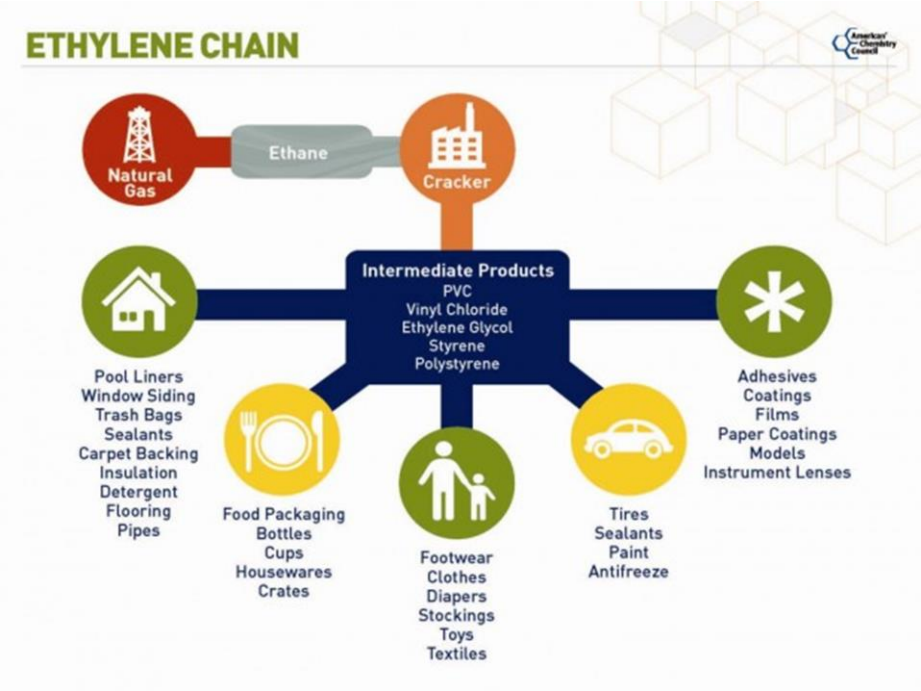
[30] http://www.americanchemistry.com/Media/PressReleasesTranscripts/ACC-news-releases/US-Chemical-Investment-Linked-to-Shale-Gas-Reaches-100-Billion.html

[31] For background, see http://www.pwc.com/en_US/us/industrial-products/publications/assets/pwc-shale-gas-chemicals-industry-potential.pdf.

In Pennsylvania, much attention is focused on Shell Chemical's proposal to build an ethane cracker facility in Beaver County. This multi-billion dollar facility, the first of its kind in the region, is expected to generate many new business opportunities, along with massive job impacts related to plant construction.[32]

Figure 14 is a diagram developed by the American Chemical Council shows the types of industries that are downstream in the ethylene supply chain. Through the steam cracking process, ethylene is separated from the ethane extracted from oil and gas wells. Ethylene is then turned into intermediate products like PVC and polystyrene which are then used in a wide array of different products. Among the industries that might benefit from being proximate to this facility include chemicals, plastics, and other petrochemical byproducts.

Figure 14: Downstream Uses of Ethylene



Source: American Chemistry Council

This project has the potential to create significant opportunities for western Pennsylvania and eastern Ohio. By locating in the Marcellus region, the Shell plant will allow a number of manufacturers will be better able to manage costs within their respective supply chains. For instance, there are several polymer and converter companies in the region that turn polymers into finished products or components for other goods like automobiles.[33] The Shell facility will allow them to reduce the time and costs involved with procuring one of their key inputs.

[32] http://stateimpact.npr.org/pennsylvania/2014/03/25/businesses-already-betting-on-proposed-ethane-cracker-in-beaver-county/

[33] Seydor, Clements, Pantelemonitis, and Deshpande.

This project, however, is at least three years away from beginning as it works its way through the planning and permitting phases. Consequently, now is the time for companies and communities to begin exploring strategies for taking advantage of the opportunities that may become available through this development. When this facility finally comes online, it will be producing for industries and companies well beyond Western Pennsylvania, but there should be opportunities for local firms particularly when it comes to some of the construction demands of the project like building roads and other infrastructure.

Oil and gas refining is an industry that can fall in either the midstream or downstream segment of the oil and gas supply chain. Within the region, petroleum refinery employment grew by 2.9 percent annually between 2008 and 2013. This employment, however, remains relatively small with just over 300 jobs in the region. Given the large capital investments required with building these kinds of facilities, it is more likely that the region will export its oil and gas to places with large petrochemical complexes like Houston and the Gulf Coast or Sarnia, Ontario. The expansion of the pipeline infrastructure will further facilitate this process. As noted earlier however, the real benefit for manufacturers will come from the lower energy costs, particularly in energy intensive industries. Lower costs can help reduce operating costs and allow existing regional manufacturers to expand and invest in their current facilities.

While the chemical industry is widely expected to grow thanks to new shale gas resources, it is not alone. A recent Peterson Institute analysis assessed the projected impacts of new oil and gas investment on U.S. manufacturing sectors.[34] It found the greatest positive employment and output impacts in the following industries:

- Cutting Tool and Machinery Tool Accessory Manufacturing
- Mining and Oil & Gas Field Machinery Manufacturing
- Steel Product Manufacturing
- Air and Gas Compressor Manufacturing
- Fabricated Pipe and Pipe Fitting Manufacturing
- Pump and Pumping Equipment Manufacturing.[35]

All of these sectors are projected to see major demand increases, along with large infusions of new capital. Other industries such as fertilizer and chemical sectors will see most benefit from a reduction in energy costs as opposed to new customer demands.

[34] Houser and Mohan, pp. 82-94.
[35] Ibid, pp. 84-85.

Key Businesses in Marcellus Shale Supply Chain

Within this supply chain, companies fit within different tiers of suppliers. As laid out in the University of Pittsburgh's Marcellus Shale Supply Chain Study, the major drilling and exploration companies occupy the core of the industry with suppliers differentiated by a number of tiers.[36] These companies include large oil and gas exploration companies like Anadarko Petroleum Corporation or Range Resources. Tier 1 suppliers provide products or services directly to these companies. Companies with the "support services to oil and gas operations" (NAICS 213112) industry are often Tier 1 suppliers, and may be quite large themselves. Halliburton, for instance, is active in the drilling and fracking process and would be considered a Tier 1 supplier. Tier 2 suppliers are those companies that either provide direct products or services to Tier 1 suppliers or indirectly sell products and services to the drilling and exploration companies. A company like Schramm, which produces mobile drilling rigs for oil and gas development would be considered a Tier 2 supplier. Tier 3 supplier are those firms that sell directly to Tier 2 companies, but are more likely to indirect suppliers to a wide range of oil and gas companies as well as companies in other industries.

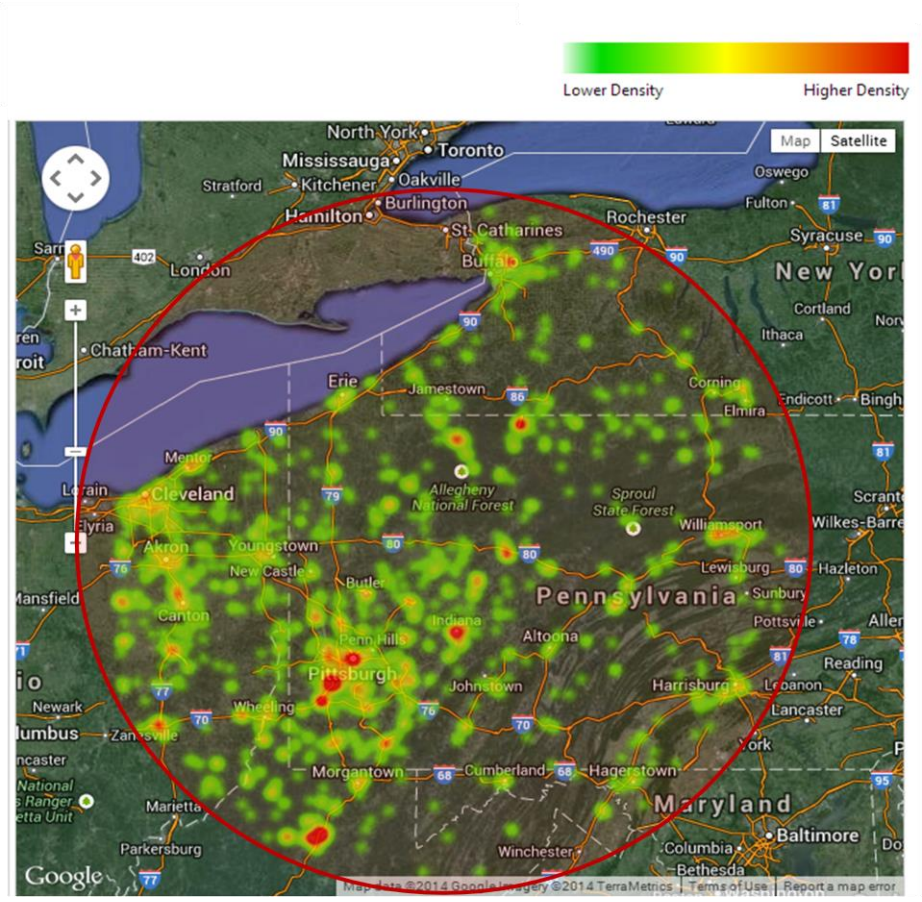
Marcellus Shale development brought many of the major oil and gas companies to Pennsylvania. Figure 15 shows where companies from the four primary oil and gas industries,[37] are located within a 150 mile radius of Clarion, PA. In addition to Pittsburgh, many of these companies have located in places like Williamsport and Canonsburg to service the drilling activities underway in the state's Northern Tier and Southwest, respectively. Within Northwest Pennsylvania, these companies are not nearly concentrated although there are a number of companies in Warren, Meadville, Erie, and Oil City.

Figure 16 identifies some of these core companies and also provides examples that companies that play supporting roles within the supply chain. Site preparation and drilling and extraction are driven primarily through investments from large companies like Anadarko Petroleum and Range Resources. Several of these companies have offices in the 8-county Northwest Pennsylvania region. Range Resources has an office in Mercer County, while Exco Resources and Seneca Resources (the exploration and production segment of Natural Fuel Gas Distribution Company) have offices in Warren County.

Many of the leasing, engineering, and technical services that go into acquiring and then planning drilling locations can also be found in Pennsylvania. Many of these companies are national firms with smaller sales or satellite locations in the Marcellus region. Even though they have a relatively small regional presence, they have the ability to reach back to their firm's main offices to access the staff and expertise needed for the jobs. Within the site preparation phase, construction is an activity that is often more labor intensive. A number of Pennsylvania-based companies like Lane Construction and PJ Dick are active in the construction activities needed to prepare drilling sites. A number of other companies focus

[36] Seydor, Clements, Pantelemonitis, and Desphande, p. 51.
[37] These industries include: Crude petroleum and natural gas production (NAICS 211111), drilling oil and gas wells (NAICS 213111), support activities for oil and gas operations (NAICS 213112), and natural gas distribution (NAICS 221210).

Figure 15: Oil and Gas companies located within 150 of Clarion, PA



Source: ReferenceUSA

on the construction of the actual well site and the drilling pad, and the environmental remediation required once the well is in place.

As noted earlier, hydraulic fracturing and horizontal drilling involve highly specialized work, and are often done by non-local companies like Halliburton, FTS International, and Schlumberger Well Services. As the industry has grown, these firms are establishing a larger local presence. Local firms, such as like Cudd Energy Services and Universal Well Services in Mercer County and Baker Hughes in Clarion County, also have a strong market presence.

Initial phases of Marcellus Shale development are aiding a number of Pennsylvania-based manufacturers. Companies like MVS Saegertown, National Oilwell Varco, and Schramm manufacture drilling equipment used well beyond just the Marcellus region. The expansion of natural gas development both regionally, nationally and internationally have also created opportunities for manufacturers of steel tubes, pumps and pumping, and lubricants that are all used in the drilling and fracking process. It has also created market opportunities for manufacturers of fracking fluids and frac tanks that store the used fracking fluids. Beyond direct manufacturing, these activities support services

like the transportation and remediation of these fluids and that too has created opportunities for Pennsylvania-based businesses.

Although some companies like EQT invest in production and midstream activities, a different set of companies tend to be more active in the midstream segment of the oil and gas supply chain. These companies include Mark West Energy, Williams Midstream Services, NiSource, Chesapeake Energy, EQT and Natural Fuel Gas Distribution; NiSource and Natural Fuel Gas Distribution have offices in the Northwest Pennsylvania region. The midstream sector often focuses on both local and national infrastructure. The local segment involves the oil and gas gathering and processing systems required in the actual oil and fields. As a result, demand for this infrastructure is greatest when new shale wells are being drilled and production levels are high. The national segment comprises the pipeline networks that transport oil and gas products around the country. It is the pipeline equivalent to the interstate highway system.[38]

Rail, trucks and barges remain the primary means for transporting oil and gas, and, as noted later in this report, CSX is making major infrastructure investments in the region in part to serve this growing demand. In particular, rail is more flexible and scalable, but the associated safety and regulatory issues has caused many companies to look to more investments in pipelines. Investments in pipelines creates opportunities for pipeline companies like Enterprise Products Partners, Sunoco Logistics, Atlas Energy and McCarl's; the latter two have offices in the region. It creates demand for natural gas compression services that are needed to move gas from low-pressure wells to gathering and processing services. Compression services are also needed to move gas into and out of storage and processing facilities.[39] Companies like Access Midstream and Exterran are therefore key support actors for both the national and local segments of the midstream sector.

Increased demand for these midstream services will not only create opportunities for the companies directly involved in transporting and distributing oil and gas products. It will also generate work in the construction trades as it will require many builders and welders to put the necessary infrastructure. Much like in site preparation phase this will also create opportunities in fields such surveying, engineering, and land services related to leasing and environmental assessments. Again like the drilling and extraction process the midstream sector will create indirect opportunities for producers of manufactured goods like pumps, piping, valves and sensors. However, taking advantage of these opportunities is not simple or straight forward. The next section describes some of the issues that firms need to consider before trying to enter into the oil and gas supply chain.

[38] *The Rise of the Midstream.* The Deloitte Center for Energy Solutions. November 2013. Available at: https://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/Energy_us_er/us_er_RiseOfTheMidstream_Nov2013.pdf

[39] https://marketrealist.com/2014/03/natural-gas-compression-industry-brief/

Figure 16: Key companies by segment of the Marcellus Shale Supply Chain

	Site Preparation	Drilling & Extraction	Midstream Activities
Core companies	• Anadarko Petroleum Corporation • Cabot Oil & Gas • Chief Oil & Gas • Consol Energy • **Exco Resources** • **Range Resources** • **Seneca Resources** • Southwestern Energy	• Anadarko Petroleum Corporation • Cabot Oil & Gas • Chief Oil & Gas • Consol Energy • EQT • **Exco Resources** • **Range Resources** • Seneca Resources • Southwestern Energy	• Mark West Energy • Williams Midstream Services • **NiSource** • Chesapeake • EQT • **Natural Fuel Gas Distribution Company**
Companies in key supporting activities	*Environmental engineering services & consulting* • AECOM • Apex Companies • Skelly & Loy, Inc *Leasing & Land Services* • Percheron • John T. Boyd Company *Construction* • Lane Construction • PJ Dick • **Campbell Construction Company** *Well site construction* • Basic Energy Services • Gas Field Specialists • Kibbe Oil & Gas Field Services *Commercial-Industrial Machinery Equipment & Leasing* • **Cleveland Brothers Equipment Co.** • Caterpillar Global Mining • Keystone Mining Services *Environmental remediation* • Arcadis • Conestoga-Rovers & Associates	*Drilling & Fracking* • **BakerHughes** • **Cudd Energy Services** • Crescent Directional Drilling • FTS International • Halliburton • McKinney Drilling • Schlumberger Well Services • **Universal Well Services** *Drilling equipment* • **MVS Saegertown** • National Oilwell Varco • Schramm • Superior Energy Services *Fracking fluids* • Flotek • Quaker Chemical *FracTanks & Groundcover Mats* • **Alturnamats** • BakerCorp • Environmental Tank & Container *Wastewater transportation & processing* • FairmontBrine (Fairmont, WV) • **Fluid Delivery Solutions** • **Pennsylvania-American Water Company** • Weavertown Environmental Group *Steel tubes, pumps and piping* • Vallourec • Allegheny Pipe and Supply • FMC Technologies *Lubricants* • Petrochoice	*Pipeline transportation* • **Atlas Energy** • Enterprise Products Partners • **McCarl's** • Sunoco Logistics *Natural Gas Compression Services* • Access Midstream • Exterran *Rail Transportation & Rail Loading Facilities* • **CSX** • Appalachian Transload Services, LLC. *Sensors* • Magnetrol *Valve and pipes* • **JM Eagle** • **Morris Coupling** • **Vertical Seal** • **Charter Plastics**

Source: Marcellus Shale Coalition & Reference USA, **Bold:** Location in Northwest Pennsylvania

Supply Chain Issues and Opportunities

The oil and gas industries, and related sectors, provide real opportunities for local sourcing. Many firms involved in these supply chains are interested in local sourcing opportunities to shorten delivery times and increase responsiveness. However, firms do not just stumble into these opportunities and they likely need to do some self-assessment to ensure that they can meet the industry's exacting needs. Much like the aviation industry, firms in the oil and gas industry have very high standards of their suppliers, and they will quickly turnover those vendors who fail to perform. For instance, one interviewee described how one large oil and gas exploration company turns over 30 percent of their vendors every two years. To compete and win in these new markets, potential subcontractors must consider several key issues.

For companies working in the oil and gas industry, quality is paramount. In fact, it is a far more important consideration than cost. The activities associated with oil and gas exploration, extraction, and distribution require a great deal of precision. Equipment used in exploration and drilling faces rigorous conditions, and the costs of equipment failure—in terms of both time and money—can be quite high. This is especially the case for activities related to drilling and exploration that often take place overseas and in out of the way places where replacement parts may be days away rather than hours.

How can firms fully embrace high quality? Firms looking to supply manufactured products or services to the oil and gas industry can demonstrate the quality of their products by investing in relevant industry certifications. In additional to prominent industry certification programs like ISO 9001, the American Petroleum Institute has developed additional certifications that reflect the industry's very exacting quality standards.[40] These certifications include API Spec Q1 for manufactured products and API Spec Q2 for service providers, along with a host of other specialized certifications such as those that focus on the traceability of steel and other factors.

While certifications are one important way in which oil and gas companies can identify quality vendors, other tools also exist. Some OEMs and other leading companies also view participation in other leading supply chains as another indicator of quality. For instance, one manufacturer of drilling rigs noted that if a vendor was selling to leading companies like Boeing or Caterpillar, then they would likely be able to meet their quality standards. Participating in these multiple value chains can benefit companies because it helps them diversify their customer base and buffer them against the ebbs and flows of any one given industry.

In addition meeting exacting quality standards, firms involved in the oil and gas industry must also have impeccable safety records. There are few industries that are as scrutinized about health, environmental and safety standards. As a result, to get work in this industry firms must not only have strong health and safety procedures and records, but they must also have the documentation necessary to demonstrate and verify these records. These quality and safety requirements can be a significant impediment for

[40] http://www.api.org/certification-programs/api-monogram-program-and-apiqr/certification-services

small firms looking to take advantage of oil and gas opportunities. The challenge is not so much that they cannot meet the desired levels of quality and safety. Rather, they often lack the resources and staff capacity to comply with all the rules and documentation used by OEMs and they cannot afford the high costs for regulatory compliance. So this is another consideration that firms must make if they look to get into these markets; they need to commit to investing in these compliance resources and capacity.

Firms must also remain flexible and maniacally focused on committing to meeting to deadlines. Vendors must be available 24/7 to meet client needs. If that means delivering a part or a service at 2 am, then that is what they must do. Beyond this level of short-term responsiveness, firms must be able to deliver on actual deadlines as well as their forecast planning. Firms working within the oil and gas industry, may also want to consider pursuing "Master Service Agreements" with major oil and gas companies as a way to better position themselves for this work. Basically, these agreements allow vendors to be recognized as pre-approved vendors. In doing so, they are more likely to be selected to do work when production increases or expands.

Before entering into oil and gas supply chains, firms must also bolster their financial position. Financial solvency is an important consideration when selecting vendors because payments may not turn around as quickly as in other industries. For instance, suppliers may get paid in 90 days rather than 30, perhaps creating cash flow challenges for smaller firms In order to help them assess the financial solvency of potential vendors, many large oil and gas companies use online vetting tools. For instance, Consol Energy and Range Resources use ISNetWorld[41], while other companies use similar services like PICS Auditing.[42] Since so many companies are looking to get into the emerging opportunities within the oil and gas industry, larger oil and gas companies need an efficient way to find potential suppliers and vendors. Service providers like ISNetWorld and PICS auditing help these larger companies by maintaining a database of potential suppliers. They also do the due diligence to ensure that these potential suppliers are financially solvent and maintain all the proper quality safety certifications among other things. This helps larger companies quickly identify a pool of potential vendors. For smaller companies, supplying their company information to these databases improves their chances of connecting to larger companies and securing potential work.

It should be noted that the emphasis on responsiveness, quality and safety all create opportunities for domestic producers. Many of these demands cannot be met by more inexpensive producers in low-cost countries and therefore there is a distinct preference for domestic producers. Many of the largest oil and gas companies are based in Texas and Oklahoma and have existing relationships with existing suppliers. Over time, more Pennsylvania-based companies have been able to capture these markets by demonstrating these key traits, and their proximity to the Marcellus Shale development has helped improve their responsiveness and reduce shipping costs. Moreover, local labor—rather than skilled laborers brought in from the Texas oilfields—is significantly less expensive. However, the strategy for small firms should not be to dive in with big firms, but rather to develop relationships with the supplier

[41] www.isnetworld.com
[42] www.picsauditing.com

companies. As a result, firms need to understand their place in the oil and gas supply chain, and use that as a key input in crafting their strategy to enter the supply chain.

Key Findings: Shale Energy Trends and Manufacturing

- The development of horizontal drilling and hydraulic fracturing made shale gas extraction a commercially viable activity. However, shale gas extraction activities remain very sensitive to larger market forces, especially the of price of gas Lower gas prices have caused exploration and drilling companies to shift their investments away from gas-rich plays and more toward 'tight oil' plays, where they can extract both oil and natural gas. Northwest Pennsylvania is well positioned to take advantage of these trends because it sits atop both the Marcellus Shale and the Utica Shale's natural gas and tight oil reserves.

- Natural gas developments have large local economic impacts. Direct drilling operations can boost output and create many high paying jobs, but they also lead to many indirect benefits by stimulating demand for support activities like manufacturing drilling equipment or transporting sand, water, and chemicals. Moreover, the influx of new residents and workers generate local demand for housing, construction and retail.

- As with most natural resources development, these activities have the potential to lead to local boom and bust cycles. The demand for capital and labor to prepare the drilling locations and begin extraction can overwhelm what are often rural economies. After constructing the drilling sites and infrastructure employment trends tend to plateau and slowly decline.

- Approximately 1,700 people work in the four industries (Crude petroleum and natural gas production, drilling oil and gas wells, support activities for oil and gas operations, and natural gas distribution) most directly involved in the region's Marcellus Shale development. Regional employment grew faster than the US, and combined these industries more than doubled in employment between 2001 and 2013. During the same period, industry employment within Pennsylvania has more than tripled due to growth in southwest Pennsylvania and the Northern Tier. These activities are a growing, yet still small, part of the local economy. In comparison, health care, the region's largest sector, employs more than 54,000 people.

- These activities have created real business and employment opportunities, but the real benefit from the natural gas development will come in the form of cheaper energy for home owners and large energy users. Cheaper oil prices are especially important for cold weather states and regions that use greater amounts of oil to heat homes. Many manufacturers—particularly in energy intensive industries like chemicals, aluminum, glass and cement manufacturing— will benefit from lower energy costs. These lower costs may not only reduce their operating costs, but also encourage them to expand and invest in their current facilities.

- Site preparation and drilling and extraction are driven primarily through investments from large companies like Anadarko Petroleum and Range Resources. These investments have created opportunities for companies involved in industries related to relevant leasing, engineering, and technical services. However, these activities generate more employment in industries like construction and truck transportation.

- Investments from large oil and gas companies drive the drilling and extraction phase, but the actual hydraulic fracturing and horizontal drilling processes are highly specialized work. As a result this work is often done by non-local companies like Halliburton, FTS International, and Schlumberger Well Services. That said, this activity has also generated demand for a number of Pennsylvania-based manufacturers like MVS Saegertown, National Oilwell Varco, and Schramm that manufacture drilling equipment used well beyond just the Marcellus region. The expansion of natural gas development both regionally, nationally and internationally have also created opportunities for manufacturers of steel tubes, pumps and pumping, and lubricants that are all used in the drilling and fracking process.

- Midstream activities involve the transportation, storage and distribution of oil and gas products. Significant midstream companies operating in the Marcellus region include Mark West Energy, Williams Midstream Services, NiSource, Chesapeake Energy, EQT and Natural Fuel Gas Distribution Rail. Increased demand for midstream services creates demand for trucking, rail, and pipeline transportation services. The needed infrastructure investments will generate demand for the construction trades and services like surveying, engineering, and land services. They also create indirect opportunities for producers of manufactured goods like pumps, piping, valves and sensors.

- The completion of the ethane cracker plant in Beaver County has the potential to create many additional downstream opportunities. In addition to a significant number of construction jobs, this project will also potentially benefit employment opportunities in industries that make extensive use out of these chemicals. This project, however, is at least three years away from beginning as it works its way through the planning and permitting phases.

- The oil and gas industries provide real opportunities for local sourcing, but suppliers must adhere to high standards of responsiveness, quality, safety and fiscal solvency.
    - Quality is paramount consideration and far more important than cost. Many suppliers invest in industry certification programs like ISO 9001 or the American Petroleum Institute as a way to demonstrate their product quality.
    - Firms involved in the oil and gas industry must also demonstrate impeccable safety records, given that few industries are as scrutinized about health, environmental and safety standards.

- Vendors must be available 24/7 to meet client needs. Beyond short-term responsiveness, firms must be able to deliver on actual deadlines as well as their forecast planning.
- Financial solvency is an important consideration because payments to vendors do not turn around as quickly as in other industries.

The Rail Industry in Northwest Pennsylvania

Located on Lake Erie and at a central point between Cleveland, Buffalo, and Pittsburgh, Erie and the surrounding region represent a historical hub for rail manufacturing. GE Transportation has had a major influence on the economy of Northwest Pennsylvania, but it is by no means the only source of manufacturing within the region. Erie has a wealth of suppliers in the freight and passenger rail market – especially industrial switchers and passenger rail. They also provide propulsion system components, electronic systems, body & interior, rail track, and signaling.

All aspects of the rail industry faced a steady decline over the second half of the 20th century. Many former household names closed shop, and new forms of transportation assumed greater importance for Americans. Nonetheless, a number of firms, such as GE Transportation, were able to develop leading market positions, and these firms have enjoyed success in recent years. Developments in high speed rail and new rail investments by the Obama Administration led to predictions of a "rail renaissance."

However, it now appears that these more optimistic projections were overstated**.** Nonetheless, many new opportunities for passenger rail manufacturing exist as new investments go forward and Amtrak and many freight rail lines upgrade and modernize their fleets.

Because of its legacy position in the industry, Northwest Pennsylvania enjoys great potential to benefit from these new market opportunities. As this industry analysis shows, the region is home to a diverse set of firms operating rail manufacturing and related industries---major OEMs like GE Transportation and Brookville Equipment, along with hundreds of subcontractors supplying a diverse array of products, services and technologies. Many of these businesses should be able to capture new contracts and markets in rail-related manufacturing as well as in related sectors such as transportation equipment manufacturing.

Introduction: Trends in Rail Transportation and Manufacturing

The rail industry in the United States is in a period of renewed growth. Much of this advance is being fueled by urgent calls for investments in critical modes of transportation and by having so much pent-up work needing to be done. Infrastructure as a whole has experienced budget cuts and underfunding for decades now; America's Society for Civil Engineers gives our nation's overall infrastructure a D+ overall grade, and reports that a $3.6 trillion investment is needed by 2020 to bring the U.S. to an acceptable level of improvement.[43] Rail infrastructure, in particular, is still recovering from decades of disinvestment compared to other forms of transportation.

Once a dominant industry in America, rail experienced a decades-long decline following WWII. The rail industry was ascendant prior to World War II, building track over massive expanses and riding a wave of innovation.[44] The rise of the automobile, however, led to a decrease in interest in rail and subsequent disinvestment nationally. Unstable demand in the 1970s and 80s led to a stagnation in the ability of U.S. companies to keep up with the latest technology advancements in rail.

While U.S. companies floundered, the international rail industry thrived. France and Japan incorporated American-made technologies into their rail networks, quickly building high-speed networks that surpass anything found in the U.S. The developing "BRICs" (Brazil, Russia, India, and China) made investments in their rail networks that dwarf anything done in the U.S. These countries committed themselves through wise investing and prudent public policy to building a rail network that not only efficiently transported people and goods, but created the largest rail manufacturing companies in the world.

In order to protect the domestic rail industry, Congress implemented a "Buy America" provision requiring domestic production of at least 60 percent of the value of subcomponents of transit vehicles and equipment. As a result, foreign suppliers moved into the U.S. market. Foreign-owned companies often can compete more effectively for new business than U.S. companies with a smaller international footprint – benefitting from the stable demand for their goods and services in their home countries, allowing them to better withstand the wide fluctuations in demand in the U.S.

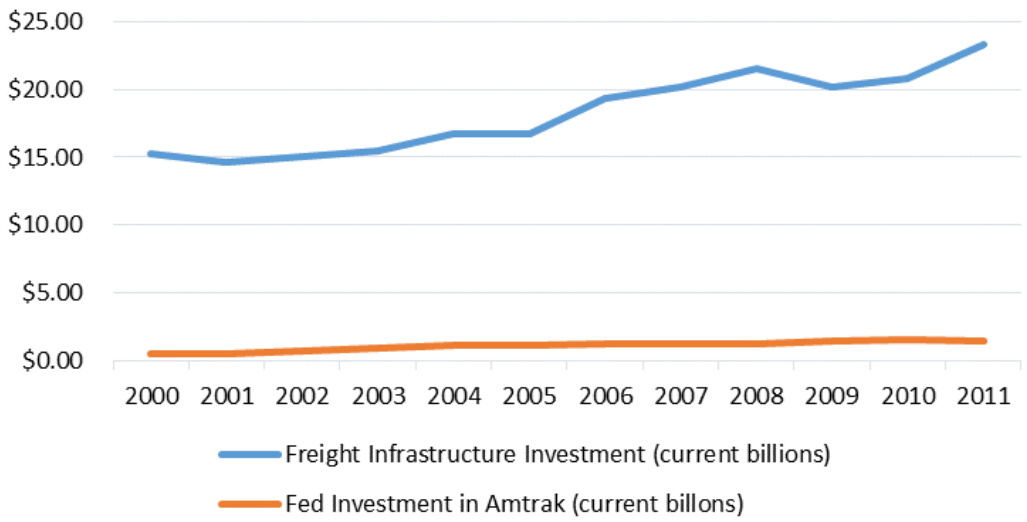
A number of industries present opportunities for growth in rail manufacturing. High-speed rail has been adopted eagerly internationally, and the U.S. is in the early stages of investing in and developing an HSR network. Amtrak, and for many metro rail systems, ridership is up. The economic stimulus bill from 2009 known as the American Recovery and Reinvestment Act (ARRA) gave a boost to some of these efforts by devoting $17.7 billion for transit and intercity rail programs – with $1.3 billion for Amtrak and $8 billion for new HSR corridors and intercity passenger rail. While passenger rail has received great attention, the opportunities in freight rail are even more significant (see Figure 17).Freight rail is expected to continue to grow exponentially over the coming years, and local governments are investing in modern streetcars to promote economic development. As with other economic sectors, new technologies will

[43] American Society of Civil Engineers, "2013 Report Card for America's Infrastructure." March 2013. Available at: http://www.infrastructurereportcard.org/a/documents/2013-Report-Card.pdf.

[44] Erik R. Pages, Brian Lombardozzi and Lindsey Woolsey, "The Emerging U.S. Rail Industry: Opportunities to support American manufacturing and spur regional development." Report prepared for the National Institute of Standards and Technology Manufacturing Extension Partnership, 2013.

also continue to reshape the operations and workings of the entire rail industry. A more detailed discussion of these trends will follow in a later section of this report.

Figure 17: U.S. Rail Investments, 2000-2011



Source: American Society of Civil Engineers

Other structural forces bode well for the reemergence of the rail industry in the U.S. Urban centers continue to grow in population relative to less rail-friendly rural areas. The Federal Railroad Administration notes that these demographic trends will result in the development of "megaregions" where larger networks of metropolitan areas will coalesce and contain 75% of the nation's population by 2050.[45] This will put a large strain on transportation networks, increasing congestion and reducing productivity. Rail has the potential to alleviate these problems, and is projected to continue to grow along with the population. Meanwhile "Millennials", those born between 1982 and 2004, increasingly are both moving to cities and buying fewer cars than past generations, portending an added need for increased investment in public transportation. Rising energy costs and concerns about climate change will also facilitate a move to more efficient forms of transportation, and rail is more efficient than air freight or trucking.

The rail industry as a whole is best understood as a value chain, with Original Equipment Manufacturers (OEMs), or Tier 1 firms, providing the design, shell (body), and final assembly of railcars or locomotives. In turn, Tier 2 firms produce propulsion, electronics, and body and interior systems that the Tier 1 firms incorporate into their final products. Tier 3 and 4 firms supply parts and materials to companies in the top two tiers. This industry structure is similar to that found in other sectors that produce large and complex technologies that require extensive systems integration by OEMs. Examples include aerospace

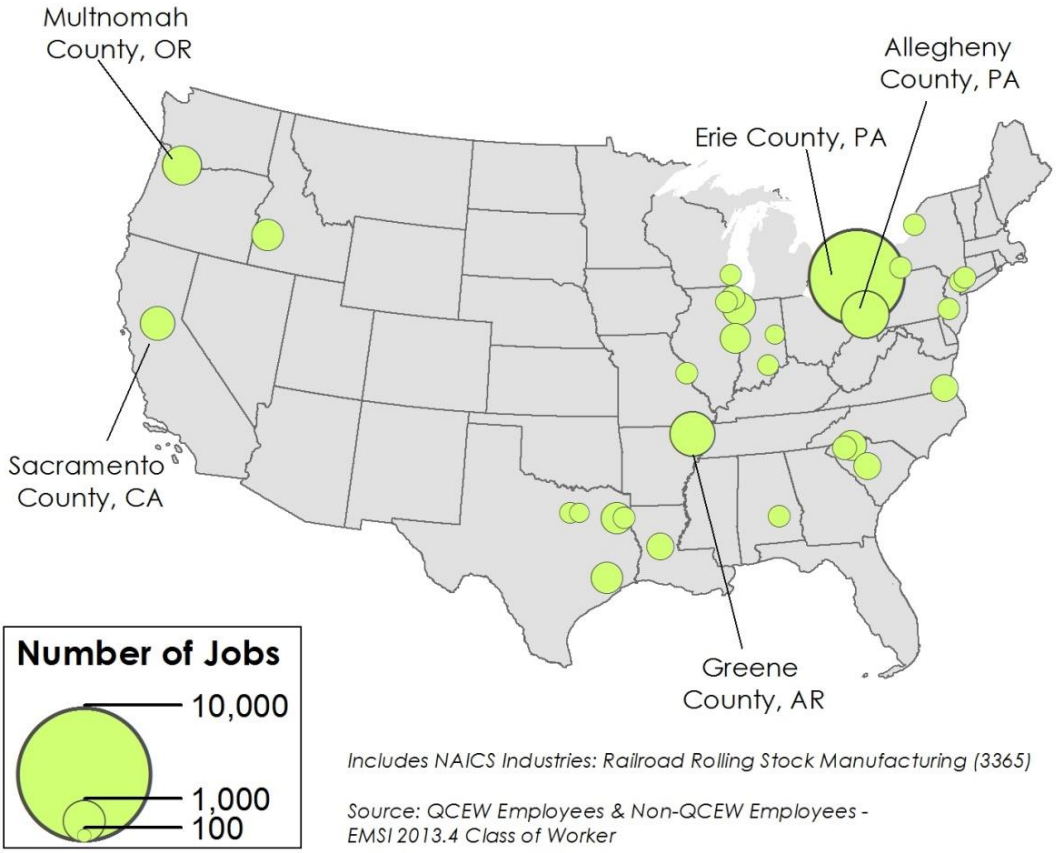
[45] Federal Railroad Administration, "National Rail Plan." For more information, visit http://www.fra.dot.gov/Page/P0522.

and many defense-related sectors. This report will outline the rail industry structure and value chain in detail, describe the strategic position of Northwest Pennsylvania within the existing rail industry, identify key businesses both locally and nationally, explore supply chain issues, and delve into industry trends. We will conclude by discussing the likely types of businesses in the region that stand to benefit from these trends going forward.

Overview of rail industry activities in Northwest Pennsylvania

Manufacturing contributes significantly to the economy of Northwest Pennsylvania. According to recent figures, manufacturing accounts for nearly 25 percent of the area's Gross Regional Product (GRP). It also represents 17 percent of total jobs in the region, and pays wages more than 50 percent higher relative to other local jobs.[46] Manufacturing provides job opportunities to more than 50,000 workers across the eight counties in the region. This makes it the second largest employing industry in Northwest Pennsylvania.[47]

Figure 18: Top U.S. Counties for Railroad Rolling Stock Manufacturing, 2013



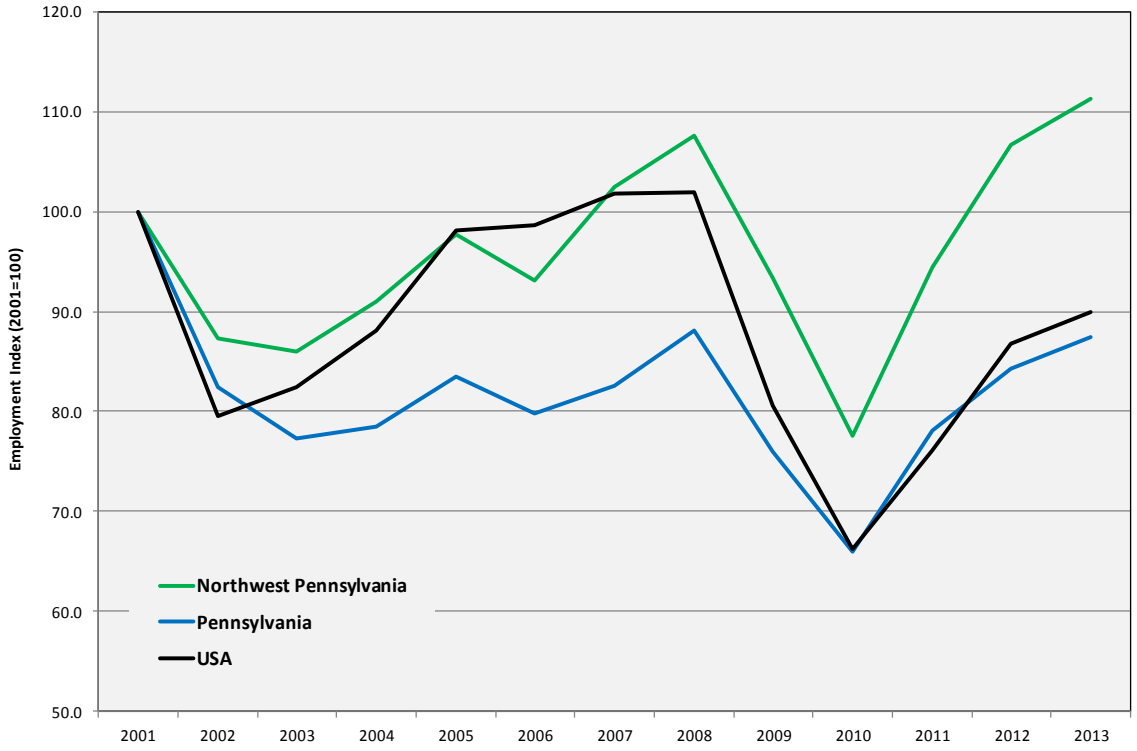
[46] Data from Economic Modeling Specialists, Inc. Jobs and wage figures are based on 2013 data and GRP 2011. Analysis conducted by Center for Regional Economic Competitiveness (CREC).

[47] Manufacturing (50,416 jobs) trailed only Health Care and Social Assistance (54,431 jobs) in total employment by major industry sector.

Within the region's manufacturing mix, Railroad Rolling Stock manufacturing represents the largest single sector, with over 5,600 jobs.[48] This industry comprises companies engaged in the manufacturing or rebuilding of locomotives, locomotive frames, and parts; making railroad, street, and rapid transit cars and car equipment for operation on rails for freight and passenger service; and those building rail layers, ballast distributors, rail tamping equipment, and other railway track maintenance equipment.[49]

Not only is railroad rolling stock the largest manufacturing segment in Northwest Pennsylvania, but the employment totals in the region, particularly within Erie County and several locations just outside the region, represent the largest concentration of jobs in this industry for the country as a whole. Jobs in Railroad Rolling Stock manufacturing are 103 times more concentrated in Northwest Pennsylvania compared to the U.S. average, indicating a high degree of company and worker specialization in the area.[50]

Figure 19: Index of Employment in Railroad Rolling Stock Manufacturing (2001=100)



Source: Economic Modeling Specialists Inc.

[48] The region's top five manufacturing sectors include: Railroad Rolling Stock (5,633 jobs); Plastics Product (4,744); Machine Shops (3,358); Metalworking Machinery (2,341); and Architectural and Structural Metals (2,152).
[49] Industry 3365 - Railroad Rolling Stock Manufacturing as defined in the North American Industry Classification System (NAICS).
[50] LQ = 106.65. Location Quotients (LQ) measure the concentration of employment of a particular industry to the U.S. average employment for that industry.

Jobs in railroad rolling stock manufacturing have also proven resilient in the region. Despite a drop over the course of the Great Recession, current employment totals are 10 percent higher than in 2001. This is well above comparable statewide and nationwide figures, where jobs are still below 2001 levels.

Railroad rolling stock manufacturing typically follows a demand-side production model where the supply is altered (i.e. production and employment) to produce just enough rail cars to meet the needs of their supply. Manufacturers in this industry, including Original Equipment Manufacturers (OEMs), operate by being awarded procurement contracts and will keep a facility open, or expand jobs, as long as they have active contracts. A typical procurement contract lasts 4-6 years. Therefore, job tenures in this industry can be volatile and are created or eliminated based on available work.[51] Successful companies in this industry must continue to win contracts by demonstrating adherence to established schedules and through the quality of the vehicles and associated products produced. The industry job trends are an indication of strength among the companies located in the region within the broader competitive marketplace.

Industry structure and value chain analysis for Northwest Pennsylvania

Railroad rolling stock manufacturing has and will continue to benefit the region's economy through its direct and indirect impacts on a range of businesses involved in the entire rail transportation supply chain process. To provide an overview of the general structure of the rail transportation industry, this section examines industries that are directly linked to rolling stock manufacturing as well as industries involved with rail infrastructure, logistics and distribution activities. In addition, this section highlights both existing strengths and gaps in the supply chain through a detailed analysis of the employment growth trends and relative concentrations of employment in these industries compared to the rest of the U.S.

Railroad rolling stock manufacturing plays a center role in this rail industry supply chain process, producing the shell (body), design and final assembly of rail cars or locomotives.[52] A national value chain statistical model is used to identify the industries that are directly involved with the components of the rail transportation supply chain mentioned above.[53] The value chain model uses national level statistical data related to the purchasing patterns of industries to measure the relative strength of inter-industry linkages. This study includes those industries that have the greatest connections in terms of spending and sales with the core industries (railroad rolling stock manufacturing and rail transportation).

On the supply side of the equation, rolling stock manufacturing is directly supported by three systems: propulsion, electronics, and body and interior. Making rail track and signaling equipment are critical as well to the rail transportation supply chain. Finally, truck transportation, warehousing and storage are

[51] Mullin, John, et.al. "Economic Impact of Locating a Transit Vehicle Manufacturing/Assembly Facility in Massachusetts: A Feasibility Study." University of Massachusetts Transportation Center, 2012.
[52] "U.S. Manufacture of Rail Vehicles for Intercity Passenger Rail and Urban Transit – A Value Chain Analysis", Center on Globalization, Governance & Competitiveness, 2010, hereafter Duke CGGC study; "Gauging Growth: The Freight Rail Supply Chain and Job Creation Potential", BlueGreen Alliance, 2011.
[53] Developed by Dr. Edward Feser, Eddie Davie Professor of Enterprise & Innovation at the University of Manchester, and Faculty Excellence Professor at the University of Illinois at Urbana-Champaign.

most closely tied to the rail transportation at the consumer side of the supply chain, in particular for freight rail transportation. The figure is color-coded to indicate the change in jobs in the past five years in Northwest Pennsylvania in a particular railroad-linked industry relative to U.S. job changes in the industry. Bold text highlights industries with significant relative employment concentration in the region compared to the national average.

Several key observations have emerged from the detailed analysis of employment trends for these selected supply chain industries:

- Railroad rolling stock manufacturing, largely due to the presence of GE Transportation, has continuously served as one of the most important job sources for Northwest Pennsylvania counties during the past decade. This data is even likely to understate the impact of these sectors as it does not include the full range of jobs and activities located at Brookville Equipment, which is located outside of the project's eight-county region.

- There are potential supply shortages in the propulsion, electronics, as well as body and interior industries in the region. Several key industries related to these three areas, including speed changer, industrial high-speed drive, and gear manufacturing, and mechanical power transmission equipment, software publishers, all other textile product mills, lighting fixture manufacturing, and paint and coating manufacturing, experienced significant decline in the past 5 years. In fact, these industries in the region shrank at a pace much faster than for the nation.

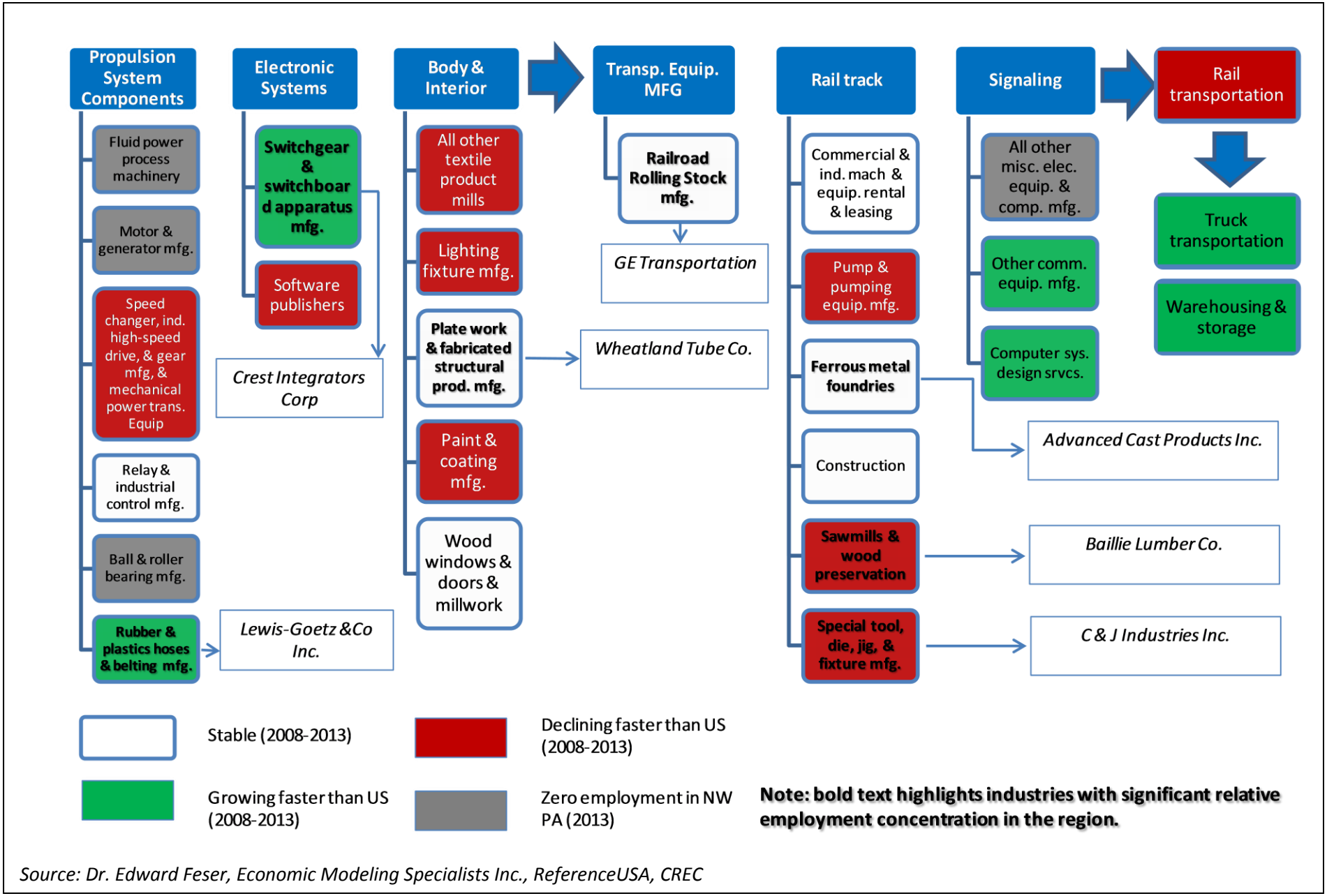
- A few key industries lack any regional presence, including fluid power process machinery, motor and generator manufacturing, and ball and roller bearing manufacturing. These declining industries and those with no presence in the region might provide potential opportunities for relevant businesses to start and expand in the Northwest Pennsylvania counties.

- Northwest Pennsylvania is home to some key businesses such as Crest Integrator Corp., Lewis-Goetz & Co Inc., and Wheatland Tube Co., which makes the region especially specialized in rubber and plastics hoses and belting manufacturing (228 workers), switchgear and switchboard apparatus manufacturing (485 workers), and plate work and fabricated structural product manufacturing (1,184 workers). The relative employment concentrations (as measured with location quotients) within these industries in the region are respectively, 4.5, 7.5, and 3.4 times higher than they are in the rest of the country. More importantly, these industries continued to grow jobs or maintained stable employment over the past 5 years.

- The region is also home to some large employers either serving or with the potential to provide rail track, including ferrous metal foundries (701 workers with relative concentration 4.5 times higher than national level), sawmills and wood preservation (569 workers with relative concentration 3.1 times higher than national level), and special tool, die, jig, and fixture manufacturing (933 workers with relative concentration 6.7 times higher than national level). Large employers include Advanced Cast Products Inc. (300 workers), Baillie Lumber Co. (65 workers), and C & J Industries Inc. (225 workers). However, a potential supply gap may have emerged in these industries as jobs decreased between 2008 and 2013.

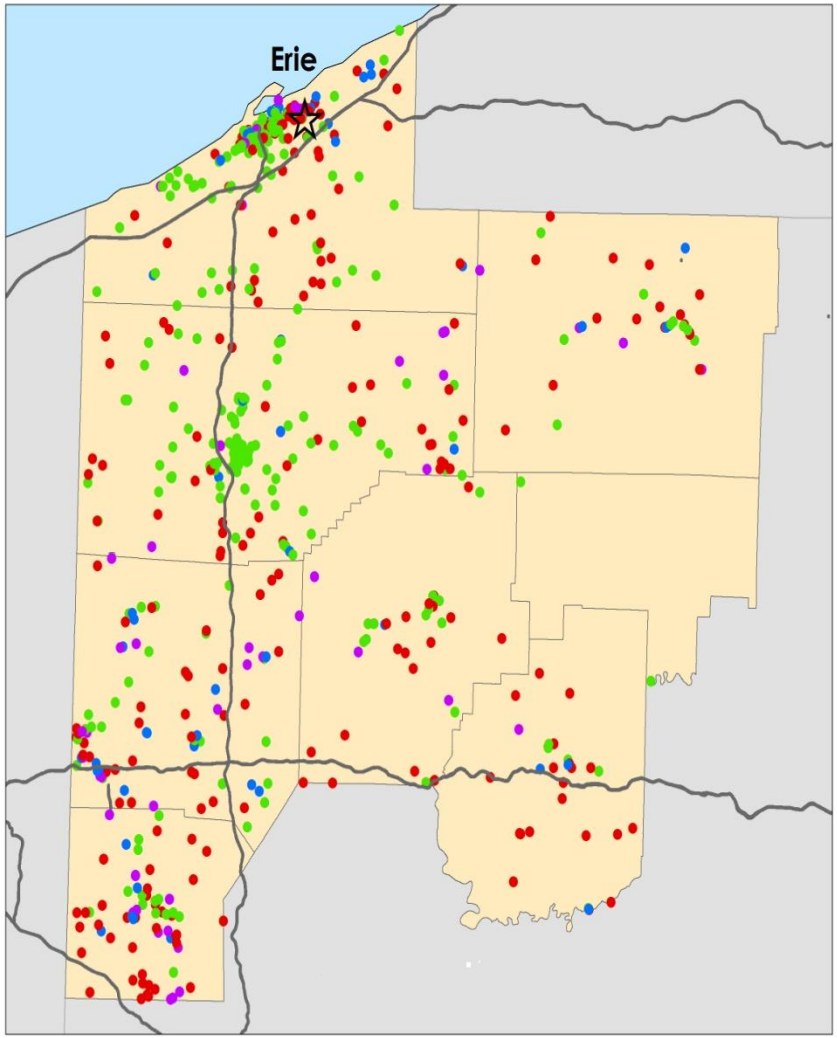
- The industries related to signaling equipment have a very limited presence in the region but an opportunity for growth might emerge in other communication equipment manufacturing and computer system design services. Both industries have added jobs at paces much faster than national level in the past 5 years.
- The presence of transportation and logistics industries tend to be stable in the region. Truck transportation and warehousing and storage all added jobs at speed faster than the national level. In 2013, these two industries employed 3,950 workers and 1,509 workers respectively.

Figure 20: Railroad Rolling Stock Manufacturing Supply Chain



Source: Dr. Edward Feser, Economic Modeling Specialists Inc., ReferenceUSA, CREC

Northwest Pennsylvania Rail Supply Chain Companies



☆Major Cities
Major Roads
Company type
Propulsion, Electronics, Body and Interior
Rail Track and Signaling
Rail Transportation
Transportation Equipment MFG
NW PA Region

Source: Reference USA

Key businesses in the Rail Industry Supply Chain

There are 20 major Original Equipment Manufacturers (OEMs) serving the U.S. rail car and locomotive market. Only seven of these firms are based in America, owing to unstable demand in the U.S. Two of these OEMs, GE Transportation and Brookville Equipment, have operations based in Northwest Pennsylvania and stand out as the major players in the industry.[54] Many of the non-U.S. firms located here in response to Buy-American rules which require domestic content in U.S. rail procurements. These global firms have captured important shares in the U.S. market. To give one recent example, Japan's Nippon Sharyo won a recent competition to build rail cars for California and Illinois, and is now producing these cars at its new facilities in Rochelle, IL.

GE Transportation has long been a major OEM both locally and nationally, having had a site in Erie for over 100 years. Their operations have a more than $2.7 billion impact on the local economy and a $3.57 billion impact on Northwest Pennsylvania, directly employing more than 4,300 people and supporting several thousand more jobs across the region through its multiplier effect.[55] Unfortunately, GE Transportation has cut nearly 1,000 jobs in their Erie plant in recent months, changing the dynamics of the rail manufacturing industry in Northwest Pennsylvania. As GE is responsible for one in every eleven jobs in the region, the loss of nearly one-quarter of GE's jobs has had a marked effect on the local economy.

Brookville Equipment Corporation manufactures diesel electric locomotives and diesel hydraulic locomotives, streetcars, and mining equipment. The company has operated in the area since 1918. A wealth of additional firms exist within the region supplying rail related parts and services. These include CAM Innovation, Inc., Control Chief Corporation, Custom Engineering, EMD, Kasgro Rail Corp., American Industries, National Forge Industries, Gateway Car Shop, Railcar Service Co., Train Masters, Wabtec Corporation, and Warren Railcar Service Inc.

Disadvantaged Business Enterprises (DBE) have opportunities to be involved in transportation manufacturing as well due to federal guidelines. In Erie County alone, OEMs can find railroad rolling stock suppliers in Diesel Electrical Equipment, Inc., HAFCO Services, Inc., RTR Technologies, Inc., UTCRAS, Inc., and ZEN Industrial Services, LLC. The U.S. Department of Transportation operates a website with a collection of directories of DBEs searchable by NAICS code. [56]

Recently, CSX, one of the nation's leading rail and intermodal businesses, has become a lead player in the development of the Erie Rail Terminal, serving as the rail line network that Erie's new terminal will run on. WhIle the terminal plans are presently on hold due to site location concerns, the project offers great potential for the region, and for the region's manufacturers who will benefit from improved distribution and logistics opportunities along with opportunities to supply firms building and utilizing the facility.

[54] For background, see Duke CGGC study

[55] Tripp Umbach, "Powering Pennsylvania: GE Transportation's Impact on the Economy and Community-at-Large in Northwestern Pennsylvania," 2010.

[56] http://www.dot.gov/osdbu/disadvantaged-business-enterprise/state-dot-and-dbe-program-websites

Figure 21: Key companies by segment in the Rail Industry Supply Chain			
Core companies	• **Alstom** • AnsaldoBreda • **Bombardier Transportation** • **Brookville Equipment** • CAF USA • **EMD** • Gomaco	• **GE Transportation** • **Hyundai Rotem** • Inekon Trams • **Kasgro Rail Corp.** • Kawasaki • Kinkisharyo • Motive Power	• Nippon Sharyo • Siemens • Skodac • Talgod • United Streetcar • US Railcar
Companies in key supporting activities	*Propulsion Systems* • ABB • ACME Industries • **Amsted Industries** • Baldor Electric • Bradken Steel Casting • **CAM Innovation Inc** • Columbus Steel Castings Co • Cummins Inc • Dayton-Phoenix Group Inc • Eagle Bridge Machine & Tool • Fairbanks Morse Engine • Flanders Electric • Hatch & Kirk Inc • Hubner • IBEG • Knorr Brake Corp • Matrix Metals LLC • **Mitsubishi Electric** • Modular Access Systems • National Railway Equipment • Omnicast • Paragon Products • **PHW** • Rockwell Automation • Saminco Inc • Snyder Equipment Co. • Tec Tran • Toshiba International Corporation • Tri-State Machining • **Wabtec Corp** *Electronic Systems* • Advanced Transit Manufacturing • Sepsa North America • Alcatel-Lucent USA Inc • **Ansaldo STS USA** • Arinc • Cisco • **Converteam Inc.** • Dayton-Phoenix Group Inc • Eaton • Elcon • Innovative Scheduling • Interalia • KLD Labs • Knorr Brake Corp • Koni North America	• Kontron AG • Kps Na • Lat-Lon • MAC Products Inc • Matrix Metals LLC • Panasonic Corporation of North America • Safety Vision • Schaltbau North America • Schunk Intec Inc • Security With Advanced Technology, Inc. • Toshiba International Corporation • Transtech of South Carolina • TTA Systems • VECOM USA • Verint Systems • Vps Control Systems, Inc. • **Wabtec Corp** • Wi-Tronix *Body & Interior* • A&A Manufacturing • Able Manufacturing and Assembly • ADTrans • Advanced Structure • Advanced Transit Manufacturing • Sepsa NA • Alcoa • AM Equipment • American Seating • Amsted Industries • Buell Air Horns • Cattco • Columbus Steel Castings Co • Dayton-Phoenix Group Inc • Dellner Couplers Group • Dialight • Driessen • Dynamic Metals • Ellcon National Inc. • Faiveley Transport • Filnor • Freedman Seating • Graham-White Manufacturing Co • Greenbrier • Griffith Rubber Mills • Hadley Products Corp • Harrington Signal • Hehr International Inc	• Hubner • Hudson Machine Works, Inc • IFE • Inca Gold Products LLC • J.T. Nelson Co • Knorr Brake Corp • Kustom Seating Unlimited, Inc • Lantal Textiles • Ledtronics • Lin Industries, Inc. • Luminator USA • Matrix Metals LLC • Maverick Technical Systems • Merak North America • Micro Precision Inc • Microphor • Milwaukee Composites • **Mitsubishi Electric** • Modular Access Systems • Mohawk Industries Inc • Motive Equipment • **North American Specialty Glass** • Northwest Rail Electric Inc • Rail Development Group • Railplan • RCA Rubber • Rocky Mountain Composites • Saft America Inc • Seats Inc. • Sigma Coachair Group • Snyder Equipment Co. • Sprague Devices, Inc • Stanrail • Stone Safety • Super Steel Products Corp • Testori Interiors Inc • Thermo King Corp • Trans-Lite • Transitair Inc • TTA Systems • **USSC Group** • Vapor Bus International • Vapor Stone Rail Systems • VECOM USA • Visual Marking Systems • **Wabtec Corp** • Westcode Inc • WEXCO Industries • **Young Windows** • Zodiac Monogram

Note:
*NW PA Companies in **bold**.*

Source: Center on Globalization Governance & Competitiveness-U.S. Manufacture of Rail Vehicles for Intercity Passenger Rail & Urban Transport

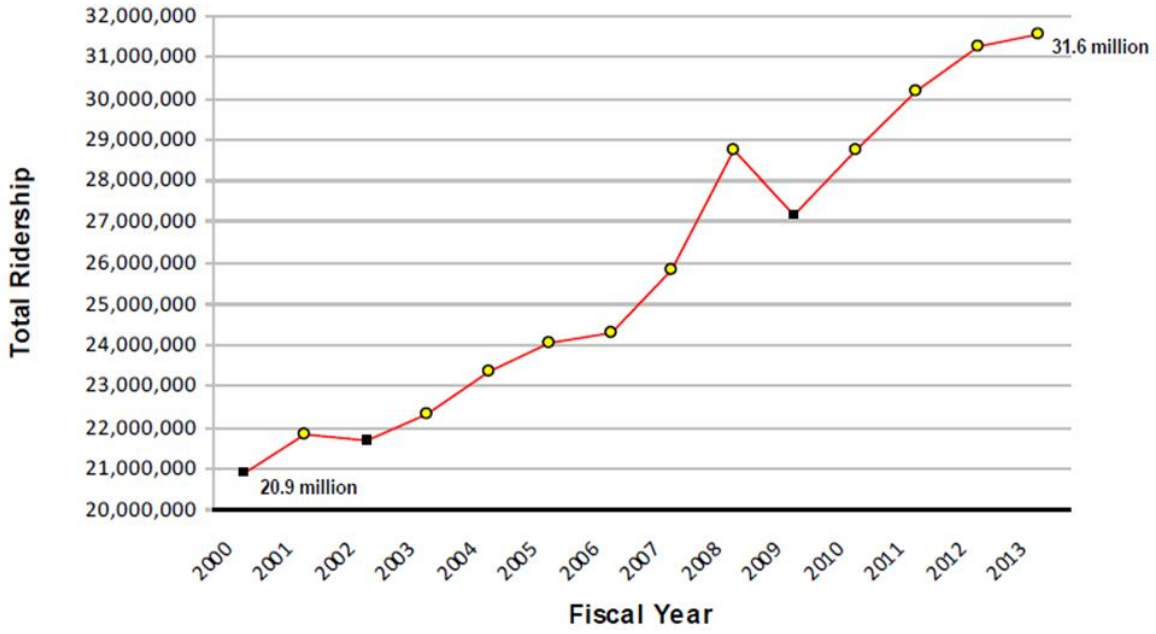
Rail Industry Trends

Passenger Rail

Intercity passenger rail and urban transit networks require significant infrastructure investments and the sustained commitment of public funds to seed and maintain a thriving system. For over sixty years, however, the overwhelming focus of U.S. transportation infrastructure spending and system development has been on highways and airports. As a result, America's technological leadership in the manufacture of subway cars, high-speed trains, and passenger rail equipment has been ceded to companies in Japan, France, Germany, and others.[57] More recently, interest has grown among policymakers and the public for renewed investments in passenger rail, fueled especially by high gasoline prices, increased traffic congestion, and calls to reduce greenhouse gas emissions to stem climate change.

This growing interest in passenger rail can be seen in increased Amtrak ridership figures in recent years. Amtrak, the national rail operator with more than 500 destinations and 21,000 route miles, carried a record 31.6 million passengers in most recent Fiscal Year 2013.[58] It is the tenth ridership record in 11 years. While much of the increase has come from increasing Amtrak ridership in the Northeast Corridor, It is reported that Amtrak now captures 75 percent of the intercity market between New York and Washington, and 54 percent between New York and Boston.[59] Rail ridership is up in many other parts of the country as well.

Figure 22: Amtrak Ridership Growth, 2000-2013



[57] Renner, Michael and Gary Gardner. "Global Competitiveness in the Rail and Transit Industry." Worldwatch Institute, 2010.
[58] "Amtrak Sets Ridership Record & Moves the Nation's Economy Forward." Amtrak release, October 14, 2013.
[59] **"**Frustrations of Air Travel Push Passengers to Amtrak." New York Times, August 15, 2012.

Additionally, many U.S. cities are looking to expand their light rail systems, in addition to making investments in the repair and replacement of the existing networks. This comes as well with the growing use of these systems and calls for even greater service across metropolitan areas.

An ambitious plan on the table that would be a "game changer" for U.S. passenger rail in the future, and the companies that serve the industry, would be the build out of the proposed 17,000 mile national high speed rail system.[60] This plan calls for a national system of high speed rail express lines connecting cities and states into an integrated system. With a proposed completion by 2030, the plan calls for having interoperable state-of-the-art dedicated track, advanced control systems, new multi-modal train stations, and top-of-the-line 220 mph trains connecting major cities together. A support network of 110 mph trains connecting smaller cities and towns together with the high speed system. Consideration of connections to regional and commuter rail, light rail, streetcars, trams, electric buses, and bicycles would also be part of the plan, to fashion a complete sustainable transportation system across the United States.

Figure 23: U.S. High Speed Rail Proposed Network Map

These trends indicating future market growth and potential major new investments in passenger rail would potentially benefit the area supply chain through the application of "Buy America." Buy America provisions ensure that federally-funded transportation infrastructure projects are built with substantial amounts of American-made products. In particular, transit vehicle OEMs must do final assembly in the United States and ensure that at least 60 percent of the manufacturing cost is spent on domestically

[60] See U.S. High Speed Rail Association at http://www.ushsr.com/ushsrmap.html

sourced components.[61] Many other procurements, such as high speed rail investments overseen by the Federal Rail Administration (FRA), require that 100% of supplied goods be manufactured in the U.S. When submitting a proposal to produce vehicles for an American customer, each OEM must submit a detailed plan showing how much of the contract will be fulfilled by domestic product. The Federal Transportation Administration (FTA) and FRA reserve the right to reject any or all proposals if they believe that the plan does not meet the requirements of the Buy America Law.

Freight Rail

U.S. economic growth is increasing demand for freight transportation, and placing great strains on all aspects of the nation's freight system, especially the freight rail system. According to the U.S. Department of Transportation, the demand for rail freight transportation will increase approximately 88% by 2035. Already America's freight-rail system is confronted by congestion and capacity choke points along national corridors, at intermodal terminals, and at urban rail interchanges. The commuter and intercity-passenger railroads, which share these rail lines with the freight railroads, share these same challenges. As a result, Class I carriers and the public sector will have to expedite their investments to meet this growing demand.[62] It is estimated that nearly 90% of the nation's existing railway capacity requires upgrades to meet these challenges and anticipated growth at a projected cost of $149 billion.

Two areas of particular growth in freight rail volumes include the transportation of shale gas and the increased shipment of goods by intermodal transport. In the past few years, the use of rail to connect energy extraction sites in the Western U.S. (e.g., North Dakota's Bakken Shale) and "tar sands" in Canada with refineries and ports on the East, West, and Gulf Coasts has grown exponentially. For instance, the number of crude oil carloads hauled by U.S. railroads surged from 10,840 in 2009 to a projected 400,000 in 2014. This trend of a reliance on rail to move this energy is expected to continue into the 2020s. While preferable from a safety standpoint, oil pipelines are expensive, take time to construct and have fixed routes, so the oil & gas industry prefers rail transport. Rail provides the transportation flexibility, "pipelines on rails", they need as production increases in one shale play and ebbs in another.[63]

In 2013, U.S. rail traffic saw record intermodal growth with 12.8 million containers and trailers shipped.[64] Intermodal freight is cargo that moves using different modes of transportation—trucks, trains, ships and barges—on the same trip without ever leaving its truck trailer or container. The method reduces cargo handling, and so improves security, reduces damage and loss, and allows freight to be transported faster. The railroad industry is gaining largely from the ongoing conversion of traffic from truckload to rail intermodal. On average, railroads are considered 300% more fuel-efficient than trucks,

[61] For more information on Buy America see the U.S. Department of Transportation Federal Transit Administration at http://www.fta.dot.gov/legislation_law/12921.html.
[62] According to the Association of American Railroads, railroads invest approximately 17% of their annualized revenues, which compares with only 3% of average U.S. manufactures' revenues on capital expenditures.
[63] "Outlook for Rail Crude Oil Transport." Rail Energy Transportation Advisory Committee. Surface Transportation Board. Mar. 14, 2013.
[64] Association of American Railroads (AAR)

resulting in lower costs and greenhouse gas emissions-and therefore the growing importance of rail intermodal.

Currently, the U.S. railroad industry handles less than 50% of total freight in America, indicating a huge opportunity for increasing market share. As a result, railroad companies are increasingly focusing on building their intermodal network across U.S. and bordering nations. One leading freight railroad company, CSX, is making investments in its intermodal network capacity in the underserved Eastern Intermodal market which has projected volumes of 9 million carloads spanning 550 miles yet to be converted into rail intermodal network from truckload. This includes a CSX investment in the Erie Rail Terminal, which the company sees as having the potential to unlock the value of intermodal transportation for shippers in northwest Pennsylvania, western New York and northeast Ohio. The focus is especially on the opportunities afforded to the region's agriculture, forestry and manufacturing industries to connect to new markets by rail.

At the time of this report's publication, the original plans to locate this CSX terminal in Harborcreek Township had been cancelled and the project's future remains uncertain. Project partners are considering other potential locations at this point. Development of this facility offers tremendous potential for the region, and will likely create many new opportunities for rail-related manufacturing as well. This project will likely spawn an industry cluster of rail, trucking and water transport, linked to warehousing and packaging, along with manufacturing. Because Erie serves as a local nexus of highways, rail lines and ports on the Great Lakes, the Erie Inland Port would also improve access for the region to new markets in Europe, helping to diversify the customer base of local firms.

Technology

As with every major industry today, innovation and the adoption of new technologies is transforming rail transportation and the rail equipment supplier network. In particular, two areas of technology adoption are having a major impact on the current market. This includes the work of the Next Generation Corridor Equipment Pool Committee (NGEC) and the industry's quick adaptation of new fuel economy technology to minimize fuel costs. Both of these trends are explored in this section.

The Passenger Rail Investment and Improvement Act of 2008 directed Amtrak to establish the Next Generation Corridor Equipment Pool Committee (NGEC) "…to design, develop specifications for, and procure standardized next-generation corridor equipment."[65] The intention of the Act is to standardize the specifications for future passenger rail equipment purchases by Amtrak for bi-level cars, single-level cars, single-level trainsets, diesel electric locomotives, diesel multiple units, and dual-mode locomotives. In this way, Amtrak will be able to potentially buy equipment faster and at a lower cost. Another potential outcome of the Act is that NGEC-developed specifications will open the rail equipment marketplace to more U.S. domestic production by creating certainty in the market and increased

[65] See Next Generation Equipment Committee at:
http://www.highspeedrail.org/Documents/2014%20NGEC%202%20pager_proof%2003_06_2014.pdf

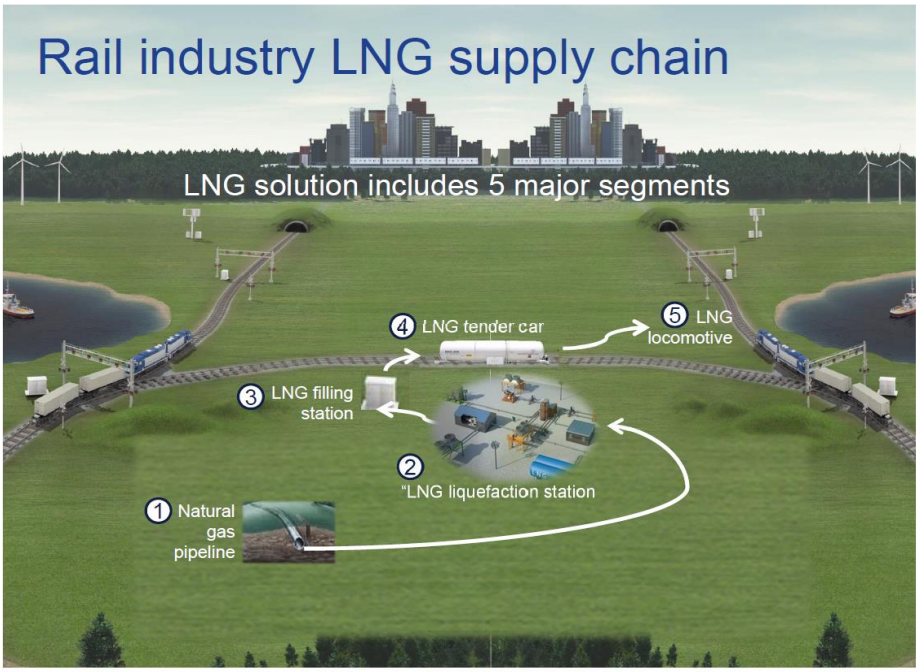
competition for awards built upon the quality and price offerings from many companies rather than a few.

Additionally, by having the NGEC create this common platform for procurement, states who wish to buy passenger rail equipment can benefit from the increased buying power afforded them making pooled purchases. Multi-state procurement has already been successfully done for the purchase of bi-level passenger rail cars among a consortium of states including California, Illinois, Missouri, Michigan and Iowa. It is also underway for a multi-state procurement of diesel electric locomotives.

There has also been high interest in the rail industry in the quick adaptation of fuel economy technology. This includes the development of U.S. shale gas deposits as a source of Liquefied Natural Gas (LNG) for use in powering locomotives. A main source of fuel for train locomotives is currently diesel fuel and the cost savings from using LNG and preferred environmental benefits are driving this interest. While locomotive manufacturers are moving to create these next generation LNG fueled locomotives, the supply chain and new infrastructure needed to meet system needs are significant.

For instance, trains would need LNG fueling stations built which includes having (1.) a natural gas pipeline; (2.) LNG processing station; (3.) fuel filling station for (4.) the newly made customized LNG built tender cars to supply gas to the (5.) new LNG locomotives and those locomotives further needing to have (6.) specialized service and repair shops. (See Figure 24).

Figure 24: Rail Industry LNG Supply Chain



Source: GE Transportation

Additionally, an LNG powered locomotive also requires significant reconfiguration of the existing structural configuration for engine locomotives. This includes a need for the significant redesigning of the cabs, systems, controls, engine and after-treatment, along with an entirely new platform, tender interfaces, and gas delivery system. These design challenges are also compounded by a preference among the potential customer base to maintain the option for "duel fuel" technologies so that the customer can continue to switch between diesel and LNG gas use. Leading companies in the LNG-fueled locomotives arena are attempting to meet this demand by working on technologies to deliver between 50-95% LNG substitution capabilities.

Supply Chain Issues and Opportunities

For those companies looking to enter railroad rolling stock manufacturing as a new business line, several considerations must be made. As with other industries, of paramount importance is the ability to deliver quality goods that meet customer desires and expectations. This also be done consistently and on-time. An important way to demonstrate this is through holding prominent industry certifications like ISO 9001, which specifies requirements for a quality management system. To gain this certification an organization needs to demonstrate its ability to consistently provide product that meets customer and applicable statutory and regulatory requirements, and to establish processes that promote continual improvement.[66] Specifically for rail, certifications like IRIS (International Railway Industry Standard) complement the existing ISO 9001 quality standard by introducing rail specific requirements.

Some firms have indicated that they would prefer to work with a more locally based supply chain, but it is not always possible to find firms that meet OEM-designated supplier certifications requirements. Even though Pennsylvania has a large quantity of suppliers already located in the state, they may not be able to compete for high-value work. Many companies in the supplier pool are not fully prepared to meet an OEM's needs. For instance, in-state suppliers may not be as well versed and experienced with the requirements of large OEMs as are their counterparts in Europe and Asia, where continuous experience in supplying rail assemblers or other large OEMs have helped to create a greater degree of sophistication about process and quality requirements, as well as industry-recognized certifications.

Specifically, some of the issues cited include low penetration of, and lack of investment in, electronic data interchange (EDI)[67] systems, which make complex production systems function more smoothly. In addition, many potential suppliers often lacked the latest quality procedures and systems. In short, too many firms were not sufficiently committed to continuous improvement; as one large OEM succinctly noted, "lean is not enough." To take advantage of the business opportunities available through major supply chains, second- and third-tier suppliers also must be world class operations. To become so, they must be willing to invest in systems and capacity to obtain and sustain industry certifications (such as, ISO 9000, AS9100, etc.), as well as the quality levels demanded by OEMs.

[66] For additional information see International Organization for Standardization at http://www.iso.org/iso/home.html

[67] EDI systems allow for structured transmission of data (e.g., financial, technical, legal, etc.) between firms and organizations.

For instance, currently several large rail OEMs, including Alstom Transport, AnsaldoBreda, Siemens Transportation Systems and Bombardier Transportation, rely on the IRIS certification when evaluating new supply chain entrants.[68] Addressing these issues is important for OEMs to be successful and for local suppliers to leverage potential market opportunities.

However, the degree of coordination between railroad rolling stock producers and their suppliers can take many different forms-ranging from arms-length market transactions (simple purchase and sale), to direct collaboration between suppliers and clients on detailed design and production specifications, to vertical integration where the OEM takes direct responsibility for both the production of critical systems and final assembly. The degree of coordination and control is often dictated by the complexity and the risk associated with failure of each individual system. Complicated and system-critical components typically require more direct oversight and interaction. Less complicated parts or materials require less interaction beyond the initial contracting.

If a company has no previous experience at all in the rail industry, and limited work with leading companies in other manufacturing supply chains, then several steps can be taken. First, a preference for supplier redundancy and effective order delivery experience with other prominent companies also offers access to the rail industry for aspiring companies. In the railroad equipment business, OEMs will often build redundancies into their supply chains by contracting with multiple suppliers for the same assembly or component to reduce the risk associated with reliance on a single supplier. Likewise, second tier suppliers often make similar products for competing OEMs. It is estimated that each tier two firm supplies seven to eight OEMs, with a third of tier two firms reporting they supply more than 10 OEMs.[69]

Second, even if you do not plan to be a prime contractor right away, make sure you have registered in the different government vendor databases. For instance, companies that want to participate in federal contracts need to be registered in the System for Award Management (SAM), which is the official U.S. Government consolidated contracting system.[70] There is no fee to register for the SAM site. Companies that want to participate in state and local contracts need to be registered in the state's vendor link. Many prime contractors look to these databases to research the capabilities of subcontractors and may even identify specific subcontractors to solicit for quotes or proposals. The U.S. Small Business Administration's (SBA) Dynamic Small Business Search is also important for companies that want to participate in federal contracts.[71] This database includes a company's basic registration information from SAM, but it also gives companies an opportunity to add supplemental information including keywords and a capabilities narrative. The federally backed Procurement Technical Assistance Center (PTAC) assist small firms seeking to the government contracting marketplace. In NW PA, these services are provided by the Northwest Pennsylvania PTAC, which operates from offices in Oil City.

[68] For additional information see International Railway Industry Standard at http://www.iris-rail.org/
[69] For background, see Duke CGGC study.
[70] See https://www.sam.gov/portal/public/SAM/#1
[71] More information about the Dynamic Small Business Search is available at https://dsbs.sba.gov.

Finally, the rail industry is a business that is drive by be relationships, so newer firms need to make the right connections. Relevant industry and membership organizations are a good starting place for making connections in the field. Taking advantage of these different resources and services properly will help you get your information in front of prime contractors and large businesses, and with the right follow through, will lead to new opportunities.

Broader Opportunities in Transportation Equipment Manufacturing

If your company is already working in the railroad rolling stock manufacturing, it may be worth considering that some other transportation equipment manufacturing sectors in nearby regions also provide significant potential opportunities for suppliers in Northwest Pennsylvania counties. These sectors require many similar types of engine, electronics, and body and interior inputs and thus offer potential new markets for smaller suppliers. The advantage of this to businesses is that a diversity of customers creates a more resilient company that can weather tough times.

Given the prevalence of just-in-time production systems and continued demand to reduce the time to market, proximity can be an important factor in site location for transportation equipment manufacturers. Moreover, motor vehicles and parts such as seats, engines, transmissions and body panels, are large, heavy, and sometimes fragile, which increases transportation costs.[72] As a result, large OEMs often have the ability to influence the location of their key suppliers.

There are roughly 825 transportation equipment manufacturers, including those in the rail equipment manufacturing sector, located within a 150 mile radius from Northwest Pennsylvania.[73] These transportation equipment manufacturers are scattered throughout the area, but are most densely located around the Cleveland OH, Pittsburgh PA, Buffalo NY, Rochester NY, and Detroit MI metropolitan areas. More than half, or 423 companies, are involved with motor vehicle parts manufacturing.

Given the emphasis on just in time supply delivery practices in transportation equipment manufacturing, it is not surprising as areas near Northwest Pennsylvania represent some of the most concentrated motor vehicle production in the nation. Some good examples include Delphi Thermal System, an automobile radiator manufacturer in Lockport NY and General Motors in Warren OH. These two companies employ 4,000 to 5,000 workers each and both have over $1 billion sales volume annually. By being only several hours away from these transportation manufacturers, the suppliers in the Northwest Pennsylvania counties gain significant competitive advantages over their competitors in most places in the nation.

[72] For instance see Timothy Sturgeon, Olga Memedovic, Johnannes Van Biesebroeck and Gary Gereffi, "Globalisation of the Automotive Industry: Main features and Trends," *International Journal of Technological Learning, Innovation and Development*, Vol. 2, Nos. 1 and 2, 2009, p. 14.

[73] According to Reference USA, a frequently updated national business database carrying 24 million business records. Erie PA was used as the center point for the 150 mile radius map.

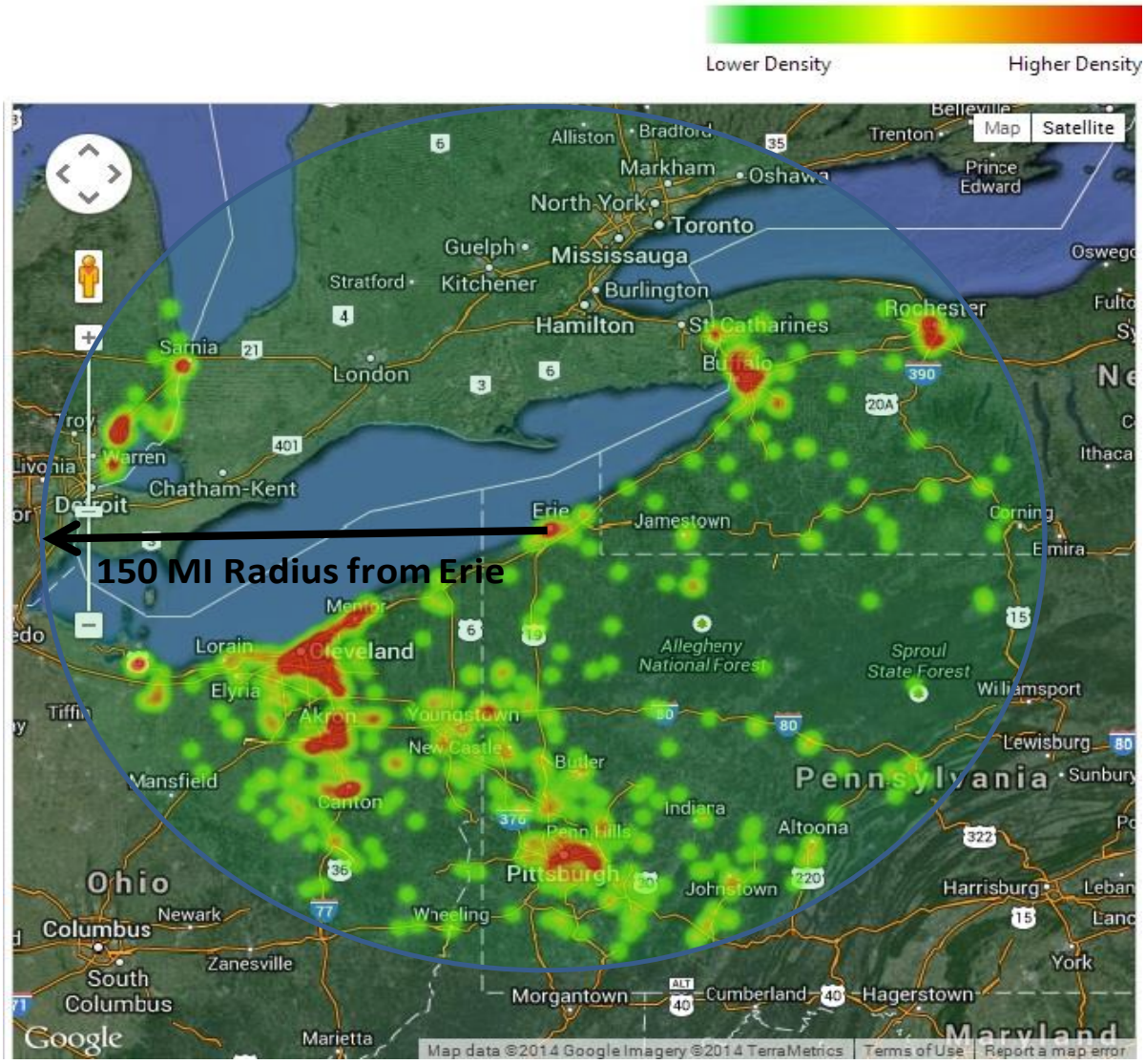


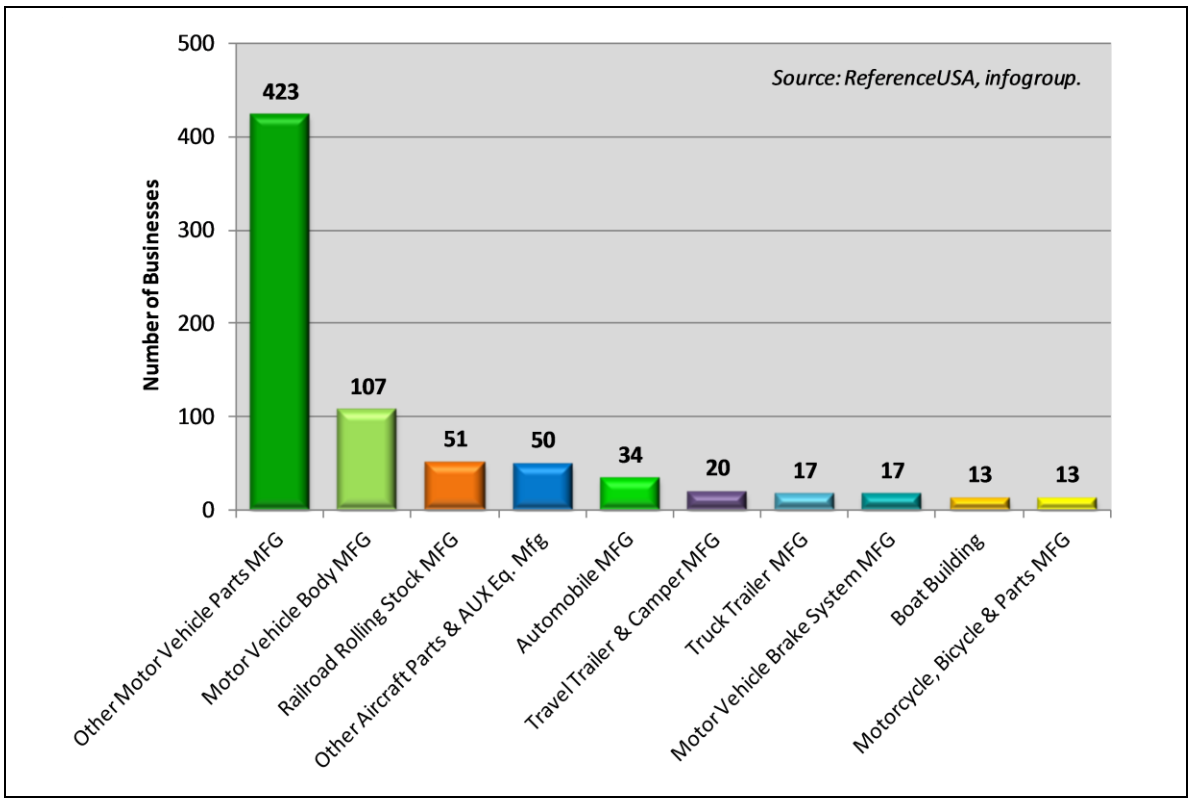
Figure 25: Transportation Equipment Manufacturers located within 150 Miles of Erie, PA

Source: ReferenceUSA

Undoubtedly, these transportation equipment manufacturers generate huge demands in many industries related to propulsion system components, electronic system, and body and interior mentioned above. Some obvious linkages include motor generator manufacturing, gear manufacturing, rubber and plastic hoses and belting manufacturing, switchboard apparatus manufacturing, plate work and fabricated structural product manufacturing, and special tool, die, jig and fixture manufacturing. In fact, some of these large employers mentioned above such as Lewis-Goetz & Co Inc. and C & J Industries Inc. are already supplying other transportation equipment manufacturing sectors (automobile) besides

rail. These potential opportunities in the broad transportation equipment manufacturing sector are critical to the sustainability of the regional economy, especially when the region faces downsizing of major employers such as GE Transportation.

Figure 26: Top Industries for Transportation Equipment Manufacturers within 150 Miles Radius



Source: ReferenceUSA

Railroad rolling stock manufacturers and several other types of transportation equipment manufacturers such as aircraft parts and auxiliary equipment manufacturers, trailer manufacturers, boat builders, and motorcycle, bicycle and parts manufacturers, comprise a large remaining share of these 825 companies. In addition to GE Transportation, other large regional rail firms include Pittsburgh's Ansaldo Sts USA (600 workers) and WABCO Locomotive Products in Wilmerding PA (400 workers). Seventy percent of these transportation manufacturers are small- and medium-sized companies with less than $10 million in sales volume. At the same time, about 10 percent (80 companies) of these transportation equipment manufacturers generate at least $50 million sales on annual basis.

The nature of transportation equipment manufacturing puts a premium on price, with suppliers typically generating very small operating margins. Price offered is generally the dominant factor in contract awards, followed by suppliers' manufacturing capability, capacity, reputation, and reliability. In order to remain competitive, firms must continuously invest in improving their processes and developing new products. Assets are available to help companies improve their competiveness. For instance, the

Northwest Pennsylvania Industrial Resource Center works with companies to implement lean (or efficient) manufacturing practices and improve quality procedures by pursuing industry recognized certifications such as ISO 9001.[74]

Start-ups, or companies looking to compete on factors other than costs, must find opportunities outside of the supply chains of the large OEMs. This means looking to small volume, high quality sellers or trying to compete in emerging technologies. Innovative products and processes enable these firms to meet specialized needs, allowing the company to compete on innovation rather than on price. Responsiveness to and even anticipation of customer needs, creative approaches to problem solving, and products that address technical problems all tended to create a higher profit margin. Ultimately, successful businesses operating with small production runs must find multiple customers. A diversity of customer base often leads to a diversity of products that help the company remain successful in the face of market contractions. However, these companies must also find their customers where they operate—in global as well as domestic markets.

Therefore, the Northwest Pennsylvania region is surrounded by several important transportation equipment manufacturing hubs such as Cleveland OH and Pittsburgh PA, which might bring additional growth points for the rail suppliers in the region.

Key Findings: Rail and Transportation Equipment Manufacturing

- Many new opportunities for rail manufacturing exist as new investments go forward and Amtrak and many freight rail lines upgrade and modernize their fleets. Because of its legacy position in the industry, Northwest Pennsylvania enjoys great potential to benefit from these new market opportunities.

- Northwest Pennsylvania is home to a diverse set of firms operating rail manufacturing and related industries---major OEMs like GE Transportation and Brookville Equipment, along with hundreds of subcontractors supplying a diverse array of products, services and technologies. Many of these businesses should be able to capture new contracts and markets in rail-related manufacturing as well as in related sectors such as transportation equipment manufacturing.

- There are 20 major Original Equipment Manufacturers (OEMs) serving the U.S. rail car and locomotive market. Only seven of these firms are based in America, owing to unstable demand in the U.S. Two of these OEMs, GE Transportation and Brookville Equipment, have operations based in Northwest Pennsylvania and stand out as the major players in the industry.

[74] For more information see http://www.nwirc.org/

- Not only is railroad rolling stock the largest manufacturing segment in Northwest Pennsylvania, but the employment totals in the region, with over 5,600 jobs, represent the largest concentration of jobs in this industry for the country as a whole. Jobs in Railroad Rolling Stock manufacturing are 107 times more concentrated in Northwest Pennsylvania compared to the U.S. average, indicating a high degree of company and worker specialization.

- The rail industry as a whole is best understood as a value chain, with Original Equipment Manufacturers (OEMs), or Tier 1 firms, providing the design, shell (body), and final assembly of railcars or locomotives. In turn, Tier 2 firms produce propulsion, electronics, and body and interior systems that the Tier 1 firms incorporate into their final products. Tier 3 and 4 firms supply parts and materials to companies in the top two tiers. This industry structure is similar to that found in other sectors that produce large and complex technologies that require extensive systems integration by OEMs.

- Railroad rolling stock manufacturing typically follows a demand-side production model where the supply is altered (i.e. production and employment) to produce just enough rail cars to meet the needs of their supply. Manufacturers in this industry, including Original Equipment Manufacturers (OEMs), operate by being awarded procurement contracts and will keep a facility open, or expand jobs, as long as they have active contracts.

- The region is especially specialized in rubber and plastics hoses and belting manufacturing, switchgear and switchboard apparatus manufacturing, and plate work and fabricated structural product manufacturing.

- There are potential supply shortages in the propulsion, electronics, as well as body and interior industries in the region. A few key industries lack any regional presence, including fluid power process machinery, motor and generator manufacturing, and ball and roller bearing manufacturing. Declining industries and those with no presence in the region might provide potential opportunities for relevant businesses to start and expand in the Northwest Pennsylvania counties.

- As with every major industry today, innovation and the adoption of new technologies are transforming rail transportation and the rail equipment supplier network.

- The most successful businesses are those seeking continuous improvement. As best practices in lean production techniques have spread, more companies are embracing at least selected lean principles to increase efficiency in their production process. In order to remain cost competitive or to sustain existing relationships with larger suppliers or OEMs, however, adopting lean manufacturing practices are not sufficient to succeed in the long run. Many of the most successful firms invest in industry-recognized certifications as a way to demonstrate internal mastery of these continuous improvement principles, not just as a pre-requisite for obtaining work from a specific customer.

- If companies are making products that respond to unique customer problems, then they must find the customers seeking their products. This means that the most successful businesses are continuously researching specialized market niches in which they are best suited to operate. Although these niches may have low-volume demands, the company quite often need not compete exclusively on price, because they can customize a product to meet the challenge. Not just cost but quality, timeliness, and impact may open more doors. Innovation enables companies selling components to other companies to create their own competitive market advantage.

Conclusions and Recommendations

As the detailed analyses presented in this report suggest, the potential for a manufacturing renaissance in Northwest Pennsylvania is strong. Even as manufacturing firms and jobs have exited from other parts of the U.S., Northwest Pennsylvania has retained a robust local manufacturing base. Much of this base has focused on areas of traditional strength, such as rail-related manufacturing. Thanks to a mix of factors, such as growing interest in rail transportation and a need for fleet modernization, the prospects for rail-related manufacturing look more promising than they have for some time.

At the same time, the emergence of low cost shale gas resources is widely considered to be a "game changer" for manufacturing firms across the U.S. Northwest Pennsylvania is well-positioned to benefit from these new resources—thanks to its location near the Utica and Marcellus Shale plays, and its past success in a diverse set of manufacturing industries.

Trends in these two broad industry sectors are generating exciting potential opportunities. However, at this point, it is best to speak of "potential" opportunities as opposed to "sure things." Many of the critical fundamentals are in place, but local leaders, corporate executives, and local manufacturers must act aggressively to build on this potential. Below, we offer recommendations that can help build a stronger base for manufacturing across Northwest Pennsylvania.

Support Development of Essential Infrastructure

Rail transportation and shale gas developments can advance hand-in-hand. Much of the current growing demand for freight rail is driven by growing use of rail as a means to transport shale oil and gas. Continued investment in regional rail infrastructure can help support further industry growth by increasing demand for new rail cars and equipment, expanding broader demand for freight rail, and by reducing transportation costs for local manufacturers.

Regional leaders should continue to support catalytic investments such as the proposed Erie Rail Terminal. While this project currently remains on hold, it offers great opportunities to spur industry growth in the future. This effort along with continued investments in warehousing and distribution infrastructure can help further solidify Northwest Pennsylvania's position as an important regional logistics hub.

Tap Critical Federal and State Funding Streams

As the movement to promote the reshoring of manufacturing gains momentum, we can expect that an increase in new investments from federal, state, and local governments. Regional leaders must position themselves to compete for and win existing and new investment opportunities. Through partnerships like the NW PA PREP initiative, Destination Erie, and the Make It in America workforce development program, key regional partners already have a good track record of securing outside investments. Continued focus on this important work is needed. In addition to support regional economic and workforce development programs, regional leaders should also aggressively tap into outside funds that

can help spur further development in key manufacturing sectors such as rail and transportation and in sectors related to shale gas development.

Build on Key Cluster Strengths at the Regional and Local Levels

Despite the importance of these manufacturing sectors, few communities across the U.S. are formally targeting the rail manufacturing or shale gas sectors as parts of their regional economic development strategies. In recent years, several regions and states have begun more concerted efforts to focus public attention and resources on these sectors. For example, the Marcellus Shale Coalition (Pennsylvania) and the Ohio Oil and Gas Association have emerged as strong advocates in the shale gas sector. Few regions actively promote rail manufacturing as a target industry. One example is the Long Island Forum for Technology's (LIFT) Rail Alliance is the only such regional effort targeting passenger rail manufacturing opportunities. The LIFT Rail Alliance, managed by the region's NIST-MEP center, was started with support from Rep. Tim Bishop (D-NY) and has also received funding support from the U.S. Small Business Administration. In addition, many regions and states, such as New Jersey and North Carolina, include transportation equipment manufacturing as part of a broader statewide cluster focus on advanced manufacturing.

In an effort to further spur growth in key manufacturing sectors, regional and local economic development agencies should support the development of regional networks to support and advocate for these industries. These initiatives can take the form of new networks focused on rail and transportation manufacturing (such as Long Island's LIFT) or could be connected to existing networks for small and medium-sized manufacturers, such as NW PA PREP or the regional IRC networks.

These new networks should focus on several important functions. First, they should help firms identify and capture new market opportunities at home and abroad. Second, they should build stronger supply chain connections. This task typically involves a mix of effective publicity and communication along with enhanced transparency and connections between firms within the supply chain. Regular network events to connect suppliers and learn about industry trends are an important first step in this work. These efforts should also embrace the use of new online supply chain connection tools. For example, Connectory.com is a nationwide web-based network that contains profiles of companies in a host of industries and levels of the supply chain. In addition to its national database, the Connectory also includes specialized regional networks such as defense and aerospace suppliers located in San Diego or in the Pacific Northwest. Finally, networks can help firms and industries deal with pressing workforce development challenges. Finding a qualified workforce has been a major challenge across Pennsylvania, particularly in the fast growing sectors related to shale gas development.

These regional efforts should be supplemented with support programs targeted to the local level. Communities in the first wave of Marcellus Shale development, such as Washington and Lycoming Counties, have developed excellent local initiatives to support industry development. These types of initiatives are now being developed in Northwest Pennsylvania. For example, the Northwest Oil and Gas Hub Taskforce sponsored a wide range of local and regional events. The community of Titusville is also presently completing a strategic plan to help guide its own local development of shale gas resources.

Enhance Overall Business Support Service Capacity

While many local manufacturers face challenges unique to operating in either the rail/transportation or shale-gas sectors, many of their growth challenges result from other less-industry-specific factors. Like entrepreneurs in other sectors, manufacturers need access to sophisticated consulting and business support tools.

Thus, these regional networks need to do a better job of linking local manufacturers to high-quality business development support, technical support from university researchers, and to a range of outside investment options. In some cases, firms within these manufacturing sectors should be connected to existing and new NIST MEP Center programs such as ExporTech or supply chain optimization. Connections to financing are also crucial. Firms entering new rail markets will need outside investment to purchase new equipment, provide necessary training, obtain needed certifications and the like. Without new infusions of working capital, their ability to retool could be hampered.

Embrace Excellence across Supply Chains

These manufacturing sectors offer real opportunities for local sourcing, but only if local suppliers adhere to high standards of responsiveness, quality, safety, and fiscal stability. Being local is not enough. Vendors must embrace quality and excellence if they hope to develop new and profitable supply chain connections.

Small business support to help manufacturers achieve industry recognized certifications could bring real benefits to many local firms. For small firms, engaging with larger OEMs typically requires compliance with industry recognized standards. Those standards vary widely from industry to industry. In general, companies use certifications as a third-party validation of the work processes and likely product outcomes. For example, the well-known International Standards Organization (ISO) 9000 standard certify a firm's quality management procedures and practices. For certain industries, ISO certification is sufficient but, for others, the certifications or regulatory requirements can be quite specialized. For instance, an AS9100 provides a basic quality standard for the aerospace industry.

Obtaining these certifications and registrations can be cost prohibitive, and create a serious barrier to small companies seeking to capture new supply chain opportunities. Assistance and funding support to pursue certifications may help local firms compete in these new markets. This type of assistance has been usefully provided in a number of states, such as North Carolina and Arizona.

Appendices

Appendix A: Industry Trends in Key Oil and Gas-related Industries

Category	Sub-category	Industry Label	Geography	2008 Jobs	2013 Jobs	08-13 Annual Growth Rate	2013 LQ
Site Preparation	Exploration & leasing	Scientific R&D Services	NW PA	25	20	-4.4%	0.0
			U.S.	417,993	440,077	1.0%	
		Architectural, engineering, & related services	NW PA	646	587	-1.9%	0.3
			U.S.	990,813	957,870	-0.7%	
		Support activities for oil & gas operations	NW PA	335	518	9.1%	0.8
			U.S.	223,635	292,032	5.5%	
		Lessors	NW PA	93	51	-11.3%	0.5
			U.S.	39,752	46,879	3.4%	
	Site Construction	Architectural, engineering, & related services	NW PA	646	587	-1.9%	0.3
			U.S.	990,813	957,870	-0.7%	
		Construction	NW PA	9,642	9,363	-0.6%	0.7
			U.S.	7,437,420	6,076,868	-4.0%	
		Commercial & industrial machinery & equipment rental & leasing	NW PA	51	58	2.6%	0.2
			U.S.	127,149	133,618	1.0%	
		Truck transportation	NW PA	3,626	3,950	1.7%	1.4
			U.S.	1,393,766	1,367,920	-0.4%	
		Environ. Remediation Services	NW PA	82	39	-13.8%	0.2
			U.S.	72,004	76,192	1.1%	
Drilling & Extraction	Drilling	Drilling oil & gas wells	NW PA	77	137	12.2%	0.7
			U.S.	92,640	95,415	0.6%	
		Construction	NW PA	9,642	9,363	-0.6%	0.7
			U.S.	7,437,420	6,076,868	-4.0%	
		Mining & oil & gas field machinery MFG	NW PA	1,233	1,286	0.8%	6.5
			U.S.	75,690	92,994	4.2%	
		Metalworking Machinery MFG	NW PA	2,982	2,499	-3.5%	6.6
			U.S.	189,337	178,550	-1.2%	
		Steel Product MFG	NW PA	1,553	1,188	-5.2%	9.7
			U.S.	60,970	57,133	-1.3%	
	Hydraulic Fracturing	Pump & pumping equipment MFG	NW PA	214	81	-17.7%	1.2
			U.S.	32,603	31,194	-0.9%	
		Metal valve & pipe MFG	NW PA	1,399	1,469	1.0%	5.6
			U.S.	125,332	123,938	-0.2%	
		Petroleum lubricating oil & grease MFG	NW PA	86	98	2.6%	4.4
			U.S.	9,964	10,410	0.9%	
		Industrial Sand Mining	NW PA	0	0		0.0
			U.S.	4,056	4,597	2.5%	

Category	Sub-category	Industry Label	Geography	2008 Jobs	2013 Jobs	08-13 Annual Growth Rate	2013 LQ
Drilling & Extraction	Extraction & production	Support activities for oil & gas operations	NW PA	335	518	9.1%	0.8
			U.S.	223,635	292,032	5.5%	
		Industrial gas & other chemical MFG	NW PA	95	95	0.0%	0.8
			U.S.	55,926	54,679	-0.4%	
		Metal valve & pipe MFG	NW PA	1,399	1,469	1.0%	5.6
			U.S.	125,332	123,938	-0.2%	
		Pump & pumping equipment MFG	NW PA	214	81	-17.7%	1.2
			U.S.	32,603	31,194	-0.9%	
		Metalworking Machinery MFG	NW PA	2,982	2,499	-3.5%	6.6
			U.S.	189,337	178,550	-1.2%	
		Steel Product MFG	NW PA	1,553	1,188	-5.2%	9.7
			U.S.	60,970	57,133	-1.3%	
		Truck transportation	NW PA	3,626	3,950	1.7%	1.4
			U.S.	1,393,766	1,367,920	-0.4%	
Midstream	Trans. & processing	Pipeline transportation	NW PA	138	162	3.3%	1.7
			U.S.	41,116	45,155	1.9%	
		Truck transportation	NW PA	3,626	3,950	1.7%	1.4
			U.S.	1,393,766	1,367,920	-0.4%	
		Rail Transportation	NW PA	521	454	-2.7%	0.9
			U.S.	233,476	242,890	0.8%	
		Sensor & other detection equipment mfg	NW PA	0	0		0.0
			U.S.	153,741	130,011	-3.3%	
		Petroleum refineries	NW PA	268	309	2.9%	2.0
			U.S.	75,099	73,003	-0.6%	
		Metal valve & pipe MFG	NW PA	1,399	1,469	1.0%	5.6
			U.S.	125,332	123,938	-0.2%	
	Storage	Oil & Gas Pipeline & Related Structures Construction	NW PA	33	56	11.2%	0.2
			U.S.	116,573	135,693	3.1%	
		Pipeline transportation	NW PA	138	162	3.3%	1.7
			U.S.	41,116	45,155	1.9%	
		Metal valve & pipe MFG	NW PA	1,399	1,469	1.0%	5.6
			U.S.	125,332	123,938	-0.2%	
	Distribution	Natural gas distribution	NW PA	459	382	-3.6%	1.6
			U.S.	107,988	111,398	0.6%	
		Electric power generation, transmission, & distribution	NW PA	793	615	-5.0%	0.7
			U.S.	402,504	394,177	-0.4%	
		Support activities for oil & gas operations	NW PA	335	518	9.1%	0.8
			U.S.	223,635	292,032	5.5%	
		Truck transportation	NW PA	3,626	3,950	1.7%	1.4
			U.S.	1,393,766	1,367,920	-0.4%	

Source: Economic Modeling Specialists, Int'l

Appendix B: Industry Trends in Key Rail-related Industries

Supply Chain Component	Industry Description	Geography	2008 Jobs	2013 Jobs	08-13 Annual Growth Rate	2013 LQ
	Railroad rolling stock manufacturing	**NW PA**	**5,447**	**5,505**	**0.2%**	**103.4**
		U.S.	**28,304**	**24,943**	**-2.5%**	
Propulsion System Components	Fluid power process machinery	**NW PA**	**0**	**0**		**0.0**
		U.S.	38,066	35,862	-1.2%	
	Motor and generator manufacturing	**NW PA**	**0**	**0**		**0.0**
		U.S.	46,413	39,630	-3.1%	
	Speed changer, industrial high-speed drive, and gear manufacturing, and mechanical power transmission equipment	**NW PA**	**195**	**104**	**-11.8%**	**1.8**
		U.S.	30,945	27,333	-2.5%	
	Relay and industrial control manufacturing	**NW PA**	**273**	**262**	**-0.8%**	**2.7**
		U.S.	50,594	46,140	-1.8%	
	Ball and roller bearing manufacturing	**NW PA**	**10**	**0**	**-100.0%**	**0.0**
		U.S.	32,660	29,322	-2.1%	
	Rubber and plastics hoses and belting manufacturing	**NW PA**	**197**	**228**	**3.0%**	**4.5**
		U.S.	26,039	23,646	-1.9%	
Electronic System	Switchgear and switchboard apparatus manufacturing	**NW PA**	**304**	**485**	**9.8%**	**7.5**
		U.S.	33,159	30,282	-1.8%	
	Software publishers	**NW PA**	**92**	**73**	**-4.5%**	**0.1**
		U.S.	261,652	288,290	2.0%	
Body & Interior	All other textile product mills	**NW PA**	**41**	**14**	**-19.3%**	**0.2**
		U.S.	43,876	37,759	-3.0%	
	Lighting fixture manufacturing	**NW PA**	**71**	**12**	**-29.9%**	**0.2**
		U.S.	46,153	35,874	-4.9%	
	Plate work and fabricated structural product manufacturing	**NW PA**	**1,214**	**1,184**	**-0.5%**	**3.4**
		U.S.	188,638	163,508	-2.8%	
	Paint and coating manufacturing	**NW PA**	**80**	**61**	**-5.3%**	**0.7**
		U.S.	41,204	39,498	-0.8%	
	Wood windows & doors & millwork	**NW PA**	**289**	**250**	**-2.9%**	**1.3**
		U.S.	127,554	89,580	-6.8%	
Rail Track	Commercial and industrial machinery and equipment rental and leasing	**NW PA**	**51**	**58**	**2.6%**	**0.2**
		U.S.	127,149	133,618	1.0%	
	Pump and pumping equipment manufacturing	**NW PA**	**214**	**81**	**-17.7%**	**1.2**
		U.S.	32,603	31,194	-0.9%	
	Ferrous metal foundries	**NW PA**	**801**	**701**	**-2.6%**	**4.5**
		U.S.	86,601	72,511	-3.5%	
	Construction	**NW PA**	**9,642**	**9,363**	**-0.6%**	**0.7**
		U.S.	7,437,420	6,076,868	-4.0%	
	Sawmills and wood preservation	**NW PA**	**910**	**569**	**-9.0%**	**3.1**
		U.S.	100,519	86,679	-2.9%	
	Special tool, die, jig, and fixture manufacturing	**NW PA**	**1,129**	**933**	**-3.7%**	**6.7**
		U.S.	68,126	65,435	-0.8%	
Signaling	All other miscellaneous electrical equipment and component manufacturing	**NW PA**	**0**	**0**	**0.0%**	**0.0**
		U.S.	28,844	27,579	-0.9%	
	Other communications equipment manufacturing	**NW PA**	**10**	**37**	**29.9%**	**0.8**
		U.S.	24,345	20,926	-3.0%	
	Computer systems design services	**NW PA**	**180**	**276**	**8.9%**	**0.2**
		U.S.	670,003	815,113	4.0%	
	Rail transportation	**NW PA**	**521**	**454**	**-2.7%**	**0.9**
		U.S.	233,476	242,890	0.8%	
	Truck transportation	**NW PA**	3,626	3,950	1.7%	**1.4**
		U.S.	1,393,766	1,367,920	-0.4%	
	Warehousing and storage	**NW PA**	**1,368**	**1,509**	**2.0%**	**1.0**
		U.S.	670,014	682,836	0.4%	
	All Industries	***NW PA***	***306,140***	***299,894***	***-0.4%***	***1.0***
	All Industries	*U.S.*	*141,293,450*	*140,562,224*	*-0.1%*	