

OHIO STATE UNIVERSITY EXTENSION

Building Sustainable Communities in Ohio's Shale Region:

Leveraging Manufacturing Clusters and
Local Assets with Strategic Planning



2015 Northeast Ohio Four County Regional Planning and
Development Organization Report
Community and Energy Series Technical Report 15-06



THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

energizeohio.osu.edu

Acknowledgments

A special thank you to the following team members for their contributions to the development of this report.

- Nancy Bowen, OSU Extension Field Specialist, Community Economics
- Eric Romich, OSU Extension Field Specialist, Energy Development
- David Civittolo, OSU Extension Field Specialist, Community Economics
- Mike Lloyd, OSU Extension Educator, CD & Co-Leader Extension Shale Work Group
- Myra Moss, OSU Extension Educator, Community Development
- Cindy Bond, OSU Extension Educator, Community Development
- James Bates, OSU Extension Field Specialist, Family Wellness
- Polly Loy, OSU Extension Educator, Family & Consumer Sciences
- Joe Bonnell, Program Director, Watershed Management

Contents

Introduction.....	3
Ohio Oil and Gas Production.....	4
EDA Shale Grant Project Overview.....	5
NEFCO Region Shale Activity.....	7
Economic Impact Analysis.....	9
Social Impact Analysis.....	16
Environmental Impact Analysis.....	24
References.....	32

Introduction

Total primary energy consumption in the U.S. has increased from 34.6 quadrillion British thermal units (Btu) in 1950 to 97.5 quadrillion Btu in 2013. Our ongoing, growing demand for energy is undeniable and as a result we are always exploring the next energy source to carry us forward. The recent technological advancement and convergence of two long practiced processes including horizontal directional drilling and hydraulic fracturing has unlocked the potential to economically recover natural gas and natural gas liquids from shale formations across the nation. For example, in the year 2000 natural gas production from shale formations represented 1% of the total U.S. natural gas production, while in 2012 the shale gas share of total U.S. natural gas production increased to 40%. Subsequently, it is projected that over the next 15 years the United States will transition from being a net importer of 1.5 trillion cubic feet (Tcf) of natural gas in 2012 to a net exporter of 5.8 Tcf in 2040 (USDOE/EIA, 2014).

While horizontal hydraulic fracturing affords a process to economically recover a critical energy source often viewed as a bridge fuel driving towards a renewable energy future, it does not come without controversy and potential consequence. The economic impacts of shale energy development include the growing demand for public and private goods and services, increasing tax revenues, and large sums of money for individual landowners. In the short term, shale energy development in the eastern Ohio region has led to an increase in economic activity, specifically in the construction phase including the drilling wells, transportation, and the establishment of pipelines and infrastructure.

However, like other natural resource-based economies, oil and gas development typically follows a boom-bust cycle. Following the development phase which normally last a few years, producing wells and completed pipelines require relatively few workers, ultimately ending the boom in economic activity. Numerous historical examples have shown that, in general, a contraction will follow an economic expansion based in the natural resource sector. Resource economies experience a boom-bust cycle that follows the rise and fall of energy prices contributing to the volatility of the local economy, thereby affecting economic growth (Farren, Weinstein, and Partridge, 2012).

While primary research focus of this project is on the regional economic impacts of shale energy development in eastern Ohio, the authors recognize there are social and environmental concerns related to horizontal hydraulic fracturing. As a result this report also includes sections that analyze social and environmental change indicators related to shale energy development within the region.



Ohio Oil and Gas Production

Oil and gas development in Ohio has been primarily concentrated on a narrow strip extending from Carroll County to Noble County. The total amount of horizontal wells drilled in the Utica/Point Pleasant shale increased from 200 in January 2012 to over 1,867 in early 2015. As wells are being drilled, the region is also seeing a rapid development of midstream processing and fractionation plants designed to clean and remove the “wet” components from the rich gas found in the region. As these plants come on line, it is likely that more wells will be drilled and a network of pipelines will be installed throughout the region and across the state to move the product from the wellhead, to midstream operations, and ultimately the end use consumers. In 2014, the state reported significant increases in the production of oil and natural gas (Chart 1 and Chart 2).

Chart 1: Ohio Natural Gas Production (2000 - 2014)

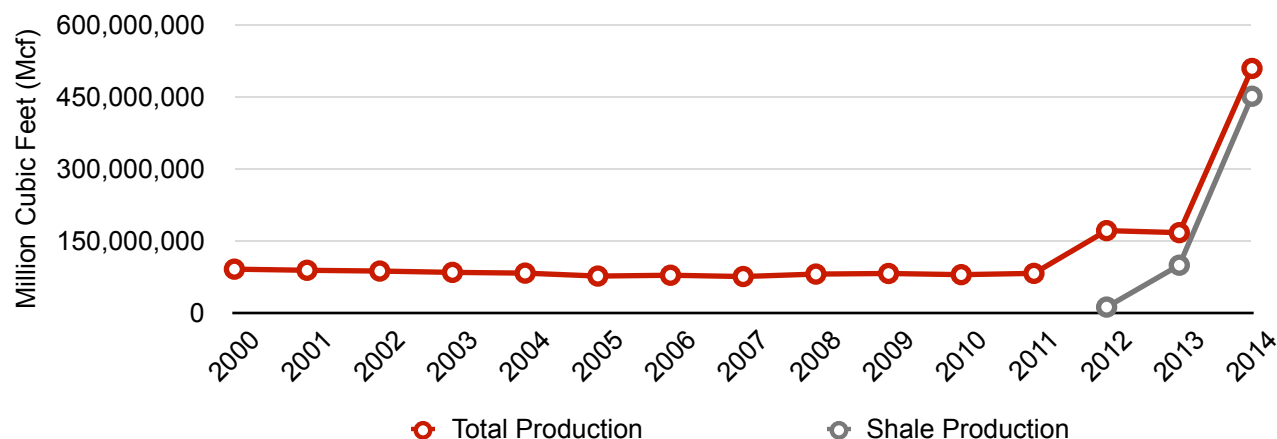
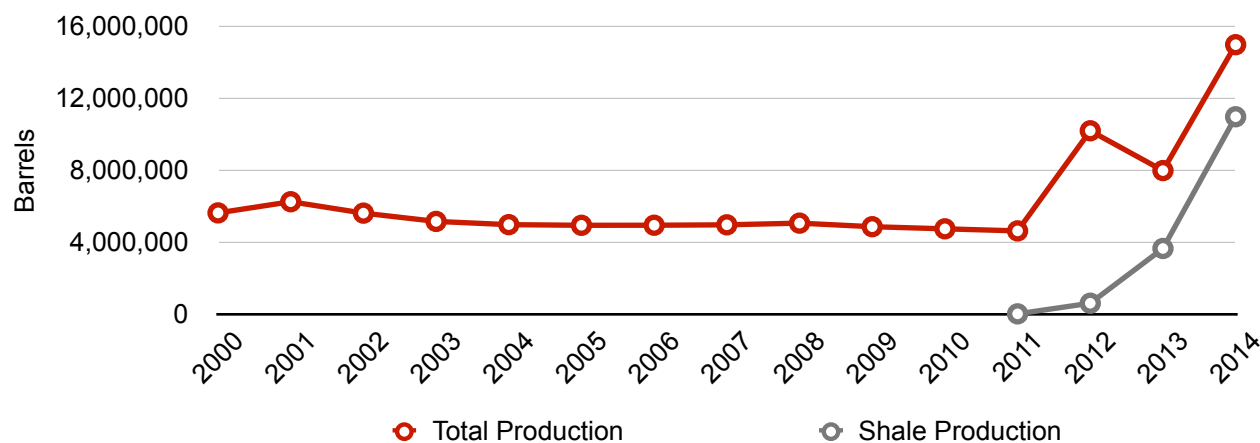


Chart 2: Ohio Oil Production (2000 - 2014)



Source: Ohio Department of Natural Resources Division of Oil and Gas Resources Management, *Oil & Gas Well Production*, 2015.

EDA Shale Energy Grant

Project Background and Overview

This Economic Development Administration (EDA) grant funded project is a collaborative initiative between Ohio State University Extension, Eastgate Regional Council of Governments, Northeast Ohio Four County Regional Planning and Development Organization, Ohio Mid-Eastern Governments Association, and the Buckeye Hills-Hocking Valley Regional Development District (Image 1). The project is designed to connect the four regional economic development stakeholders with economic research related to the current oil and gas boom in Ohio to inform the development of long term planning strategies that support long-term economic viability and community sustainability.

To achieve these goals, the project partners are focusing on the following objectives:

- 1) Developing a collaborative multi-disciplinary team of researchers and community stakeholders
- 2) Conducting research based on private and public data sources to measure change
- 3) Developing a replicable sustainable strategic shale energy planning process
- 4) Establishing implementation strategies

The primary objective of this research project is to promote long-term community sustainability and economic diversity. This can be accomplished by countering the permanent reduction of non-renewable natural resource (extraction) by proactively developing a sustainable plan to increase human, environmental, and built capital. This project will demonstrate a model, which leverages the advancement of innovation, entrepreneurship, cluster development, and sustainable strategic planning to promote economic diversity and viability.



Image 1: EDA Economic Development Districts



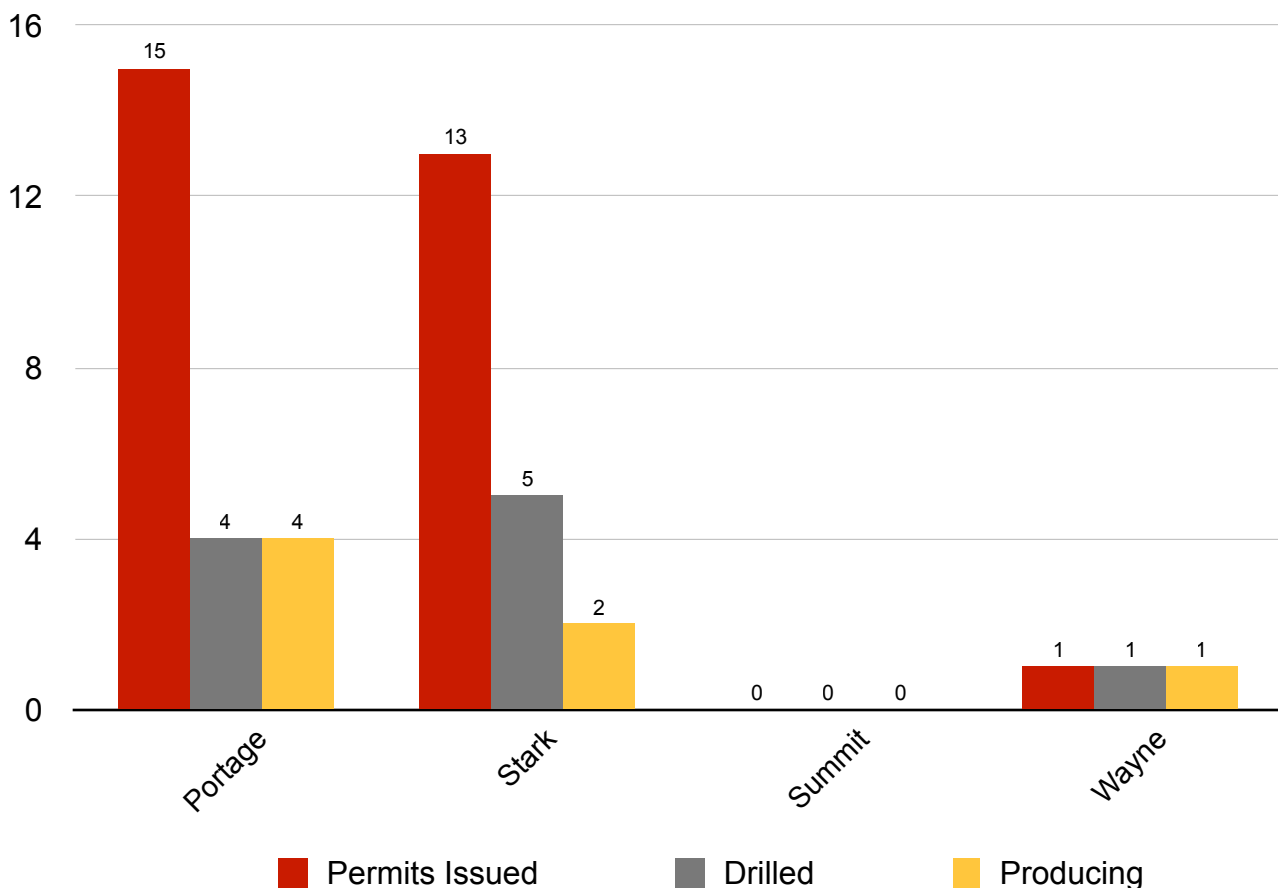
-  Eastgate Regional Council of Government
-  Northeast Ohio Four County Regional Planning and Development Organization
-  Ohio Mid-Eastern Governments Association
-  Buckeye Hills-Hocking Valley Regional Development District

Northeast Ohio Four County Regional Planning and Development Organization Region

Shale Development Overview

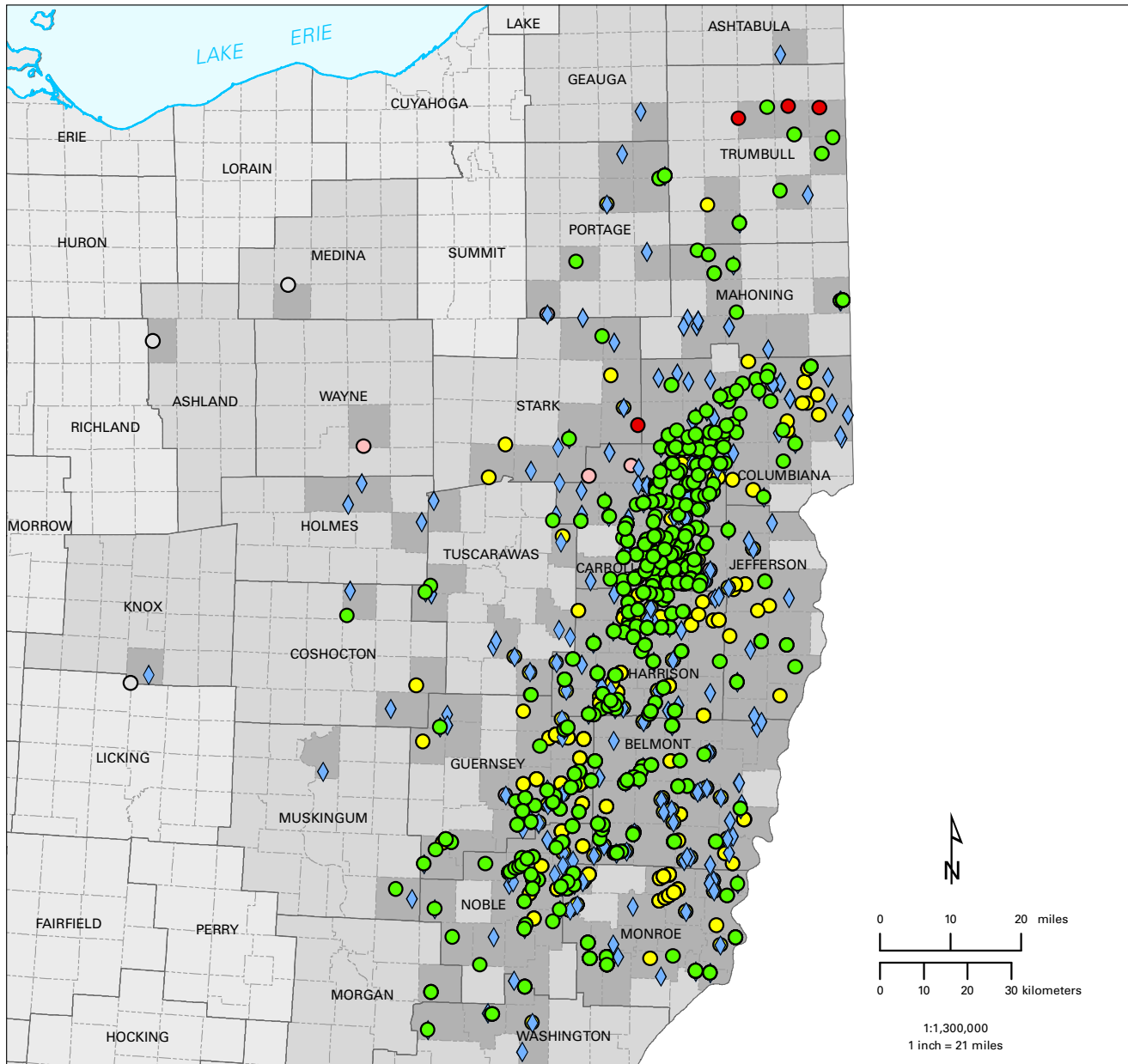
The Northeast Ohio Four County Regional Planning and Development Organization region consist of 4 counties covering 2,030 square miles in northeastern Ohio. In recent years this region has been host to a some exploratory wells, however has experienced minimal shale oil and gas development in region. The region averages less than 8 Horizontal Utica-Point Pleasant permits issued per county representing only 1% of the Ohio total. Chart 3 below summarizes the number of permits issued, wells drilled, and operating wells by county within the region. As illustrated in Image 2, this region is located slightly northwest of the current development cluster spanning from Columbiana County to Noble County.

Chart 3: Horizontal Utica-Point Pleasant Well Activity in NEFCO Region



Source: Ohio Department of Natural Resources, 2015, Horizontal Utica-Point Pleasant Well Activity in Ohio: Cumulative Permitting Activity Through 4/11/2015.

Image 2: Horizontal Utica - Pt. Pleasant Well Activity in Ohio

**EXPLANATION**

Horizontal well status as of 4/4/2015

- ◆ PERMITTED-(Permitted; Not Drilled; Canceled) (448)
- DRILLED-(Drilling; Well Drilled) (544)
- PRODUCING-(Producing; Plugged Back) (839)
- INACTIVE-(Drilled Inactive; Shut in) (10)
- Lost Hole or Final Restoration (24)
- Dry and Abandoned (3)
- Plugged and Abandoned (0)

Well permit information from the ODNR Division of Oil and Gas Resources Management

Recommended citation:

Ohio Department of Natural Resources, 2015, Horizontal Utica-Point Pleasant Well Activity in Ohio: Columbus, scale 1:1,300,000, revised 4/6/2015.



OPERATOR	COUNT
AMERICAN ENERGY UTICA LLC	146
ANADARKO E & P ONSHORE LLC	1
ANTERO RESOURCES CORPORATION	154
ARTEX OIL COMPANY	10
ATLAS NOBLE LLC	12
BEUSA ENERGY LLC	1
BP AMERICA PRODUCTION COMPANY	1
BRAMMER ENGINEERING INC.	2
CARRIZO (UTICA) LLC	16
CHESAPEAKE EXPLORATION LLC	771
CHEVRON APPALACHIA LLC	10
CNX GAS COMPANY LLC	59
DEVON ENERGY PRODUCTION CO.	13
ECLIPSE RESOURCES I LP	110
EM ENERGY OHIO LLC	6
ENERVEST OPERATING LTD.	22
EQT PRODUCTION COMPANY	8
GULFPORT ENERGY CORPORATION	213
HALCON OPERATING COMPANY INC.	13
HALL DRILLING LLC (OIL & GAS)	1
HESS OHIO DEVELOPMENTS LLC	72
HESS OHIO RESOURCES LLC	1
HG ENERGY LLC	7
HILCORP ENERGY COMPANY	38
MOUNTAINEER KEYSTONE LLC	8
NGO DEVELOPMENT CORP.	1
PDC ENERGY INC.	36
R E GAS DEVELOPMENT LLC	41
RICE DRILLING D LLC	30
SIBIRIA RESOURCES LLC	3
STATOIL USA ONSHORE PROP INC.	3
SWEP LP	1
TRIAD HUNTER LLC	18
XTD ENERGY INC.	40
TOTAL	1,868

Economic Impact Analysis

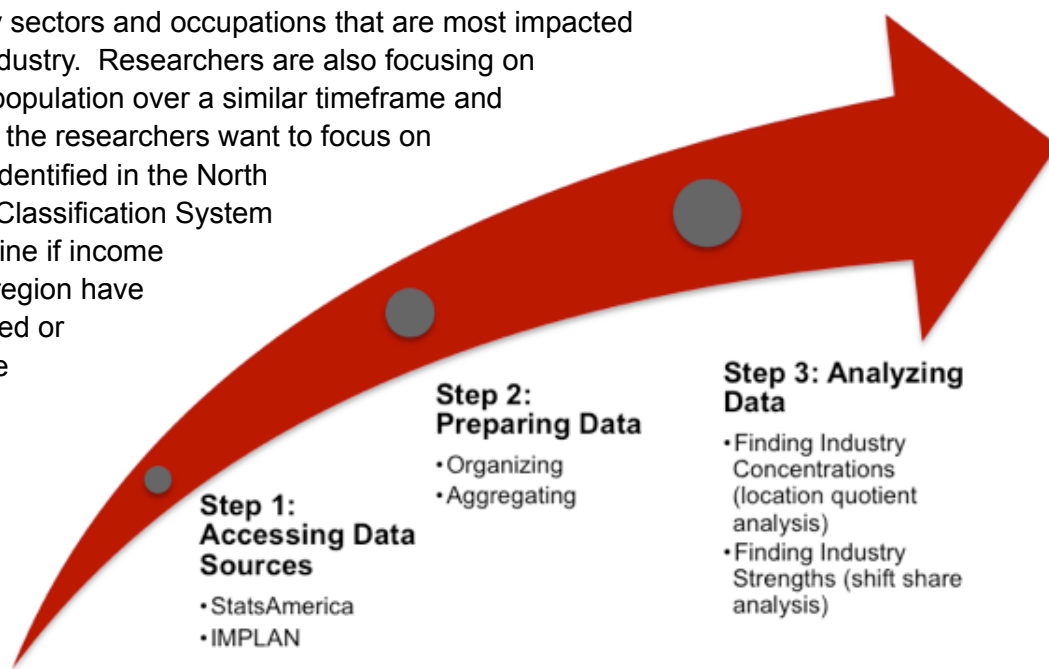


Methodology

The research focuses on the economy. It is a quantitative longitudinal study to track income and employment levels over time, measuring changes in the economy using industry cluster data developed by StatsAmerica (statsamerica.org) which includes data items obtained from hundreds of data sets from dozens of federal and state sources. StatsAmerica is an Economic Development Administration funded project and is a service of the Indiana Business Research Center (IBRC) at Indiana University's Kelley School of Business. This study also uses data sets compiled by the economic impact analysis software, IMPLAN (IMPact Analysis for PLANners).

Researchers ran Location Quotients for each of the four regions and then a conducted Shift Share analysis of the top 10 manufacturing-related clusters to measure the relative concentration and strength of the sectors. The research defined which clusters are strong due to regional or national market confluences. The specific steps to assess, prepare and analyze the data are outlined in the model below.

Unemployment data percentages were collected prior to the beginning of the shale gas initiative in 2005 and have since been collected annually. Specifically, researchers want to identify the industry sectors and occupations that are most impacted by the shale gas Industry. Researchers are also focusing on total payroll of the population over a similar timeframe and geography. That is, the researchers want to focus on industries that are identified in the North American Industry Classification System (NAICS), to determine if income levels in the shale region have increased, decreased or stayed relatively the same compared to aggregated wage data in the other regions in Ohio.



Demographic

Demographics for the Northeast Ohio Four County Regional Planning and Development Organization region were obtained from STATS America for each county within the region to include population, per capita income, poverty rate, and unemployment rate (Table 1).

Table 1: Northeast Ohio Four County Regional Planning and Development Organization Regional Demographic

County	Population		Per Capita Personal Income		Poverty Rate		Labor Force		Unemployment Rate	
	2013	2010	2013	2003	2013	2000	2013	2009	2013	2010 (Sept)
Portage	163,862	161,419	\$38,448	\$35,848	16.9%	8.2%	90,588	88,957	7.2%	8.9%
Stark	375,432	375,586	\$39,046	\$36,420	15.4%	9.1%	187,184	183,815	7.5%	10.3%
Summit	541,824	541,786	\$44,024	\$41,230	14.8%	9.6%	280,327	265,189	7.2%	9.4%
Wayne	115,071	114,515	\$33,952	\$32,654	13.1%	8.0%	57,481	55,986	6.3%	8.5%
NEFCO Region	1,196,189	1,193,306					615,578	593,947		
Ohio	11,570,808	11,536,503	\$41,049	\$38,799	15.9%	9.8%	5,765,704	5,340,860	7.4%	10.5%

Demographic Trends

- 2013 the total population of 1,196,189 is about 10.3% of the State of Ohio's population (11,507,808).
- Summit has the largest population at 541,824 followed by Stark at 375,432 in 2013. The smallest county in terms of population is Wayne County at 115,071. The overall population in the region increased by over 2,000 between 2000 and 2013.
- 2013 Per capital income in Ohio was \$41,049. Summit County at \$44,024 had the highest per capita income followed by Stark (\$39,046) and Portage County (\$35,848). With the exception of Summit County, the other 3 counties within the Region ranked below the State of Ohio's per capita income.
- The State of Ohio poverty rate in 2013 was 15.9%. Portage County, at 16.9% was above the State of Ohio's while Stark, Summit and Wayne County were below it.
- The Unemployment Rate in the State of Ohio in 2013 was 7.4%. Wayne County at 6.3% was below the State's unemployment rate followed closely by Portage and Summit (both at 7.2%). Stark County had the highest unemployment rate at 7.5%

Occupational Clusters and Trends (OES)

Northeast Ohio Four County Regional Planning and Development Organization occupational clusters were explored using an online resource, Statsamerica.com. Occupational clusters in this region fall primarily into two areas, manufacturing and Biomedical/Biotechnical, both have strong concentrations of workers in the region. With location quotients over 1 indicating a strong concentration relative to the U.S., primary metals also stands out as a very strong cluster in this region. The region actually has at least 9 manufacturing sectors that emerge as having strong concentrations in this region.

Table 2: Occupational Clusters

Industry	Employment	Concentration (LQ)
Primary Metal Mfg	2,808	3.75
Fabricate Metal Product Mfg	2,808	3.57
Chemical and Chemical Based Products	15,308	2.11
Advanced Materials	31,756	1.94
Manufacturing Supercluster	33,900	1.79
Machinery Mfg	5,292	1.63
Glass and Ceramics	1,270	1.45
Electrical Equipment, Appliance and Component Mfg	1,745	1.26
Biomedical/Biotechnical	65,044	1.17
Forest and Wood Products	4,826	1.03



Advanced Industry Cluster Analysis

OSU researchers conducted a cluster analysis for each of the four regional economic development organizations. The analysis uses 2009 as a baseline year, tracking changes longitudinally. The purpose of the cluster analysis is to provide a framework for sectoral changes that are occurring in the regional economy, and to inform shale impacted communities which clusters are growing or contracting. The objective is to better understand to what degree the regional economy is changing as a result of shale development and, if so, to what degree.

Table 3 shows the top 10 manufacturing clusters in the region between 2009-2012 based on employment change. The clusters were disaggregated to the three-digit NAICS codes using StatsAmerica. If we simply look at the number of employees in each of the clusters, it appears that only the chemicals and chemical-based products cluster increased employment during this period. Employment increased in that cluster by 112 jobs or by 1%. All other manufacturing clusters lost employment, particularly the primary metal manufacturing and forest and wood products clusters which lost 1,738 and 1,632 jobs respectively.

Table 3: Top 10 Manufacturing Clusters based on Employment Growth (2009-2012)

Cluster Description	2009 Jobs	2012 Jobs	% Change
Chemicals & Chemical Based Products	15,196	15,308	1%
Energy (Fossil & Renewable)	18,357	18,277	0%
Fabricated Metal Products	17,449	17,163	-2%
Glass & Ceramics	1,398	1,270	-9%
Transportation Equipment Manufacturing	5,685	4,919	-13%
Mining	324	274	-15%
Electrical Equipment, Appliance & Component Manufacturing	2,083	1,745	-16%
Machinery Manufacturing	6,312	5,292	-16%
Forest & Wood Products	6,458	4,826	-25%
Primary Metal Manufacturing	4,546	2,808	-38%
Source: StatsAmerica			

A variety of manufacturing clusters show strong location quotients (LQ's) in this region. The following clusters had the highest LQ results: primary metal manufacturing (3.75), fabricated metal (3.57), and chemicals and chemical based product manufacturing at 2.11. Other manufacturing clusters that have reduced in concentration based on LQ between 2009-2012 are mining (-24%), electrical equipment (-13%) and forest and wood products (-11%).

The cluster changes that are occurring in this region are primarily in the core and ancillary industries related to the manufacturing industry. Primary metal, chemicals, glass

and ceramics and machinery manufacturing are strong and continuing to grow based on the LQ's in Table 4. The region also has unique clusters that can be leveraged in manufacturing.



Table 4: Top 10 Manufacturing Clusters by Location Quotient

Cluster Description	2009 LQ	2012 LQ	% Change
Primary Metal Manufacturing	3.23	3.75	16%
Chemicals & Chemical Based Products	1.93	2.11	9%
Glass & Ceramics	1.38	1.45	5%
Machinery Manufacturing	1.6	1.63	2%
Fabricated Metal Product Manufacturing	3.57	3.57	0%
Energy (Fossil & Renewable)	0.83	0.8	-4%
Transportation Equipment Manufacturing	1.06	1.02	-4%
Forest and Wood Products	1.16	1.03	-11%
Electrical equipment, Appliance & Component Manufacturing	1.45	1.26	-13%
Mining	0.46	0.35	-24%
Source: StatsAmerica			

Table 5: Top 10 Manufacturing Clusters based on Regional Share

Cluster Description	National Share	Industry Mix	Regional Shift	Total Change
Chemicals & Chemical Based	1,217	-1,915	810	112
Mining	26	14	-90	-50
Energy (Fossil & Renewable)	1,470	-1,306	-244	-80
Glass & Ceramics	112	-300	60	-128
Fabricated Metals	1,397	-1,894	210	-286
Electrical Equipment	167	-351	-154	-338
Transportation Equipment Manufacturing	455	-388	-833	-766
Machinery Manufacturing	505	-767	-758	-1,020
Forest & Wood Products	517	-1,432	-717	-1,632
Primary Metal Manufacturing	364	-431	-1,671	-1,738
Source: StatsAmerica				



Table 5 shows the results of the shift share analysis. The shift share analysis sorts out the top growing clusters to clearly indicate which are growing based on changes in the national economy or on the regional level, or if growth is taking place due to changes within the industry itself. For instance, of the 112 jobs created in the chemicals and chemical based products manufacturing cluster, 810 of those are due to regional changes and 1,217 are due to growth within the nation (national mix), while the industry mix accounted for a loss of 1,915. Other clusters that showed a positive regional share are fabricated metals and glass and ceramics, indicating growth due to regional factors.

Implications

The Northeast Ohio Four County Regional Planning and Development Organization region shows strength in a limited number of manufacturing clusters during this recessionary period. As certain manufacturing clusters continue to grow and/or contract based on study results, workforce development will continue to emerge as a key need for this region. As companies are working to meet the challenge, local workforce will be a key component for long-term success.



Social Impact Analysis



Shale oil and gas industries have a significant impact on rural communities because of their relatively low population density and little economic and social diversification (Lendel, 2014). These communities cannot easily absorb change, and shale development has been associated with changes and challenges to social and family services, emergency response services, and law enforcement. Increased communication capacity, enhanced equipment and training, and additional individuals are needed to provide these services.

The rapid and short-term influx of out-of-state workers may change a rural community's culture. With an in-migration of temporary labor, which can be documented by the increase of beds filled in hotel/motels (i.e., bed tax), there is also a strain placed on the availability of rental property and other local resources. In addition, small community infrastructures are ill equipped to handle shale development-related emergencies and issues of public safety related to the rapid and sudden influx of temporary workers. Many small communities have limited or shared volunteer law enforcement or volunteer emergency and fire response teams. The size and duration of this influx of temporary workers is difficult to predict. However, by reviewing trends, the magnitude of shale development and the economic pace can help to predict the depth of impact.

This section considers the trends of three social factors that may be impacted by shale development. They are crime, primary and secondary student enrollment in public schools, and housing. We also report interview data collected from landowners who signed mineral rights lease agreements with oil and gas companies.

Crime and Public Safety

Public opinion survey research indicates that residents perceive that crime in their community will likely worsen as shale development increases (Theodori, 2009). At the same time, residents also believe that local police protection will likely increase as a result. This sentiment suggests an implicit trust placed in community leaders to address crime and public safety with the hiring of additional police officers (Wynveen, 2011). However, as noted above, many small rural communities in Ohio may not have funds available to do that. Regardless of whether crime rates actually change, the anticipated or perceived impacts can be a source of social disruption within a community (Wynveen, 2011).



Methodology

In this section, the number of misdemeanor summons, OVI arrests, and crashes from 2010 through 2014 are reported. These data were obtained from the Statistical Analysis Unit of the Ohio State Highway Patrol, a division of Ohio Department of Public Safety.

Chart 4: Misdemeanor Summons by Year in Northeast Ohio Four County Regional Planning and Development Organization Region

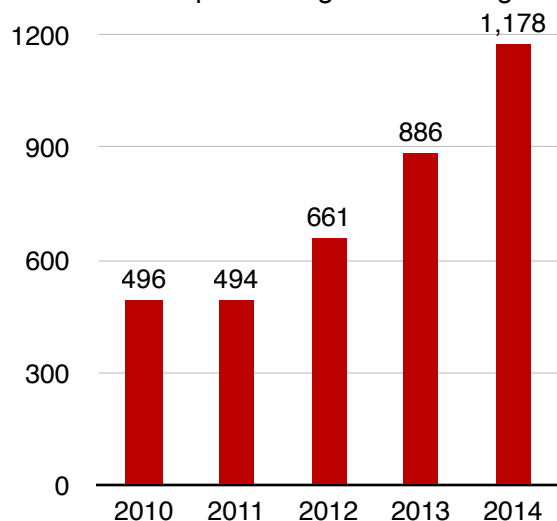


Chart 5: OVI Arrests by Year in Northeast Ohio Four County Regional Planning and Development Organization Region

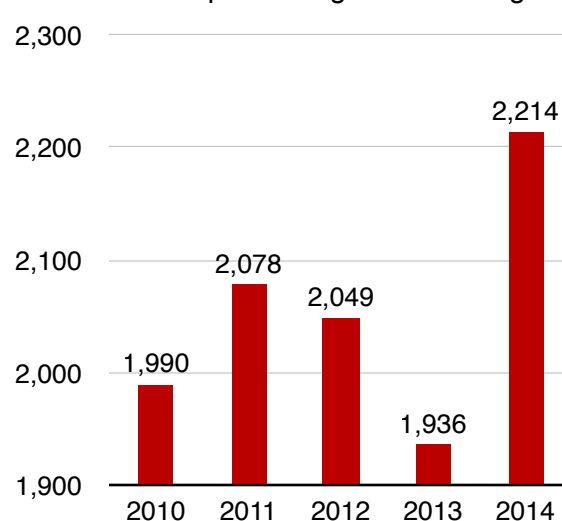
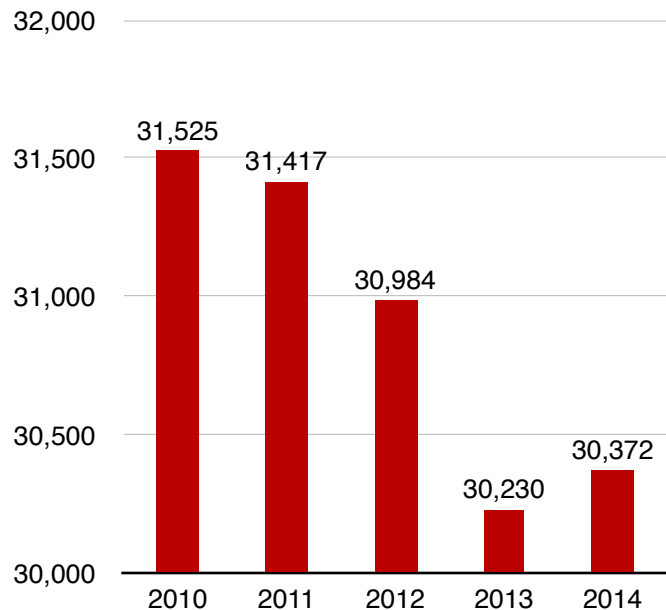


Chart 4 shows the misdemeanor summons that the Ohio State Highway Patrol issued in years 2010 through 2014. A misdemeanor summons is issued to a violator for committing a misdemeanor offense. Examples of misdemeanor offenses include assault, traffic violations, robbery, etc. A summons is a citation for the violator to appear before a court. Misdemeanor summons issued by other law enforcement agencies are not represented in these counts. For more localized data please refer to the Ohio Department of Public Safety's website (publicsafety.ohio.gov).

Chart 5 illustrates the number of OVI (i.e., operating a vehicle intoxicated) arrests made by the Ohio State Highway Patrol in counties in the region. OVI arrests made by other law enforcement agencies are not represented in these counts. For more localized data please refer to the Ohio Department of Public Safety's website (publicsafety.ohio.gov).

Chart 6 displays data on all vehicle crashes that occurred in the state (regardless of which law enforcement agency handled the accident) from 2010 through 2014 in the region.

Chart 6: All vehicle crashes by year in Northeast Ohio Four County Regional Planning and Development Organization Region



Implications

The number of misdemeanor summons has increased since 2011, while the number of crashes has trended downward since 2010. OVI arrests made by the Ohio State Highway Patrol has fluctuated over the five years reported, but in 2014 there was an increase of 278. In terms of public safety, it is encouraging that crashes have decreased over time. Efforts can be made in communities to work to prevent misdemeanors and OVIs from occurring.



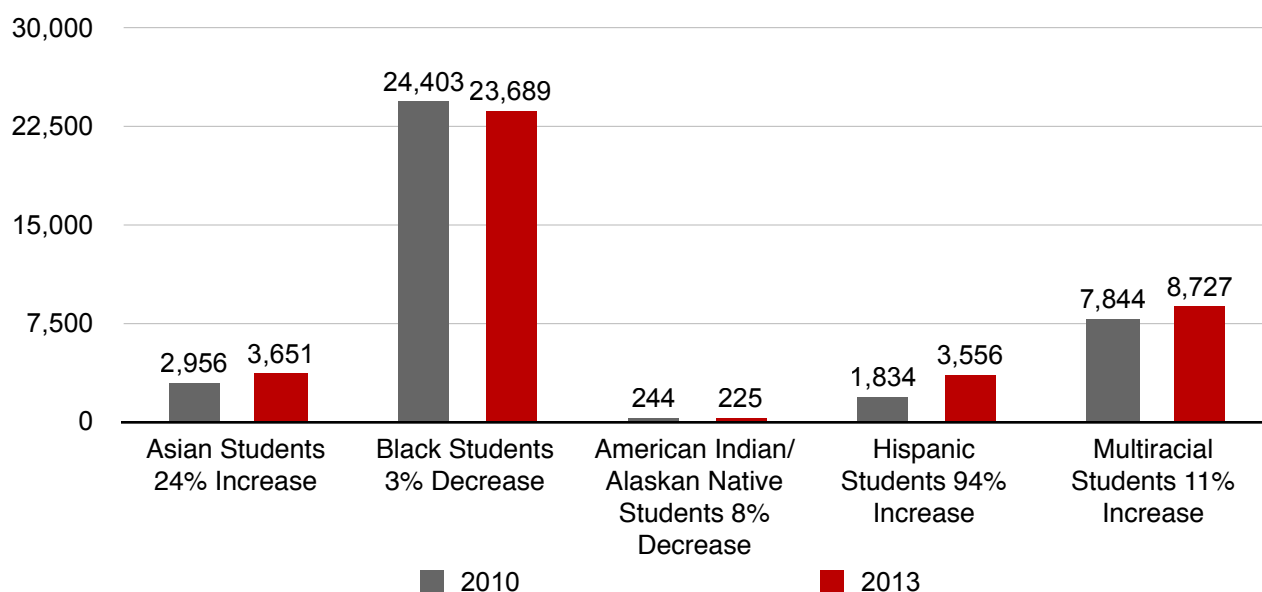
Student Enrollment in Public Schools

The influx of temporary and permanent workers to communities in this shale development region of Ohio has the potential for changing the demographic make-up of those communities. School enrollment data can be used to measure certain socio-economic and ethnicity changes within a region. Aggregated multi-county data describes broad trends, while data from individual schools and districts can pinpoint more subtle changes. Subtle but possibly significant changes in individual schools and districts may be masked by the aggregation of this data into multi-county areas. For more information about local schools, access Ohio Department of Education data tables at <http://education.ohio.gov/Topics/Finance-and-Funding/Finance-Related-Data/District-Profile-Reports>.

Methodology

Data on student enrollment in public schools is available by school district in a report called District Profile Reports (Cupp Reports) provided by the Ohio Department of Education. Data from school districts within the Northeast Ohio Four County Regional Planning and Development Organization were compiled for 2010 and 2013. Variables of interest included student ethnicity, students in poverty, students with limited English proficiency, and students with disabilities. In 2010, the total number of students enrolled at the beginning of the year (i.e., average daily membership) was 181,443 and in 2013 enrollment at the beginning of the year was 175,891, a decrease of 9.7 %. The analysis uses 2010 as a baseline year compared with 2013 data.

Chart 7: Student Ethnicity in 2010 and 2013



Note: Note: Because the populations in these predominantly rural regions are overwhelmingly white (77% in NEFCO Region), it causes the graph illustrations to minimize the bars of the much smaller minority bars, making the comparison between years difficult to see in the graph. Thus, they are not included in the chart. In this region, there was a decrease of 5.6% in the number of white students from 2010 (144,160) to 2013 (136,039), which is higher than the 1% of statewide decrease.

Northeast Ohio Four County Regional Planning and Development Organization Region

Chart 8: Students in Poverty

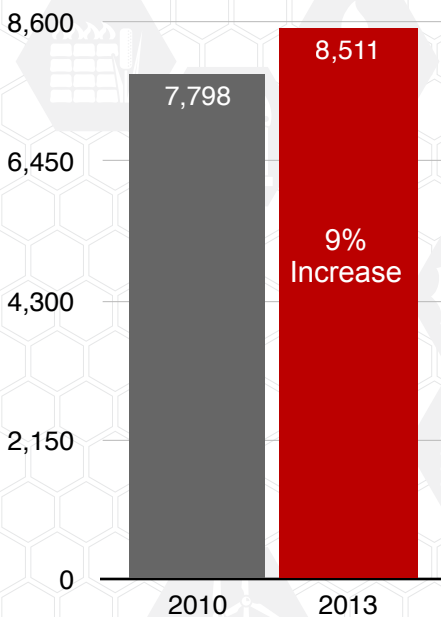
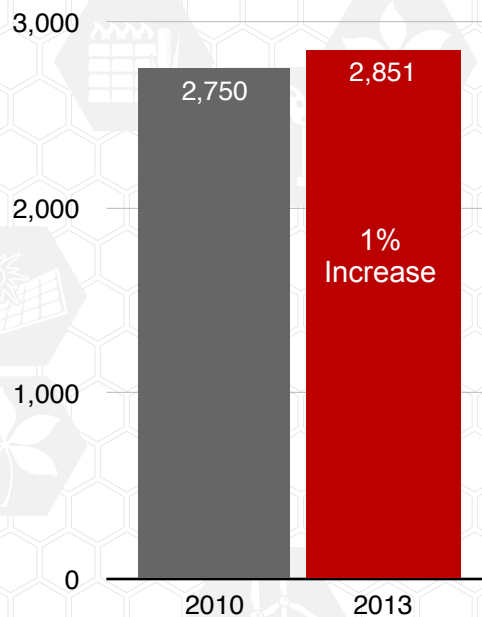


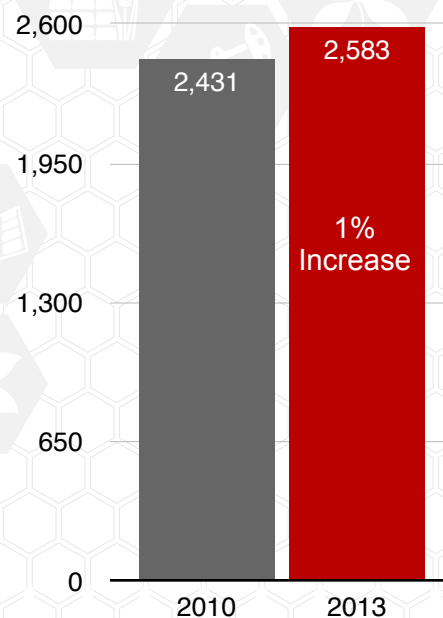
Chart 9: Students with Limited English Proficiency



Implications

Overall, throughout all four regions, the most significant trend is the increase in the number of Hispanic students. The number of students identifying themselves as Hispanic increased 94% compared to only 1% statewide. Also noteworthy is that simultaneously, the number of students with limited English proficiency increased only 1% compared to the statewide increase of <1%.

Chart 10: Students with Disability



Housing

This report acknowledges the impact shale development has on housing. Research indicates a large influx of temporary workers who require housing. This may be a wide range of housing needs including short term camp sites, hotels, rental units, as well as long-term permanent higher-end housing. Housing assets are indicated in the research as a concern for those who are lifelong members of the community and those who are seeking new housing. Establishing the correct affordability bracket of temporary and new housing helps to ensure a successful real estate market. However, at the time of this report, reliable and complete data were not available to determine housing use or availability.



Landowners' Experiences

In early 2014, Polly Loy, M.S. and James Bates, Ph.D. began a research study in Belmont County exploring landowners' experiences around shale development on their land and in their communities. Interviews were conducted with 30 landowners who were invited to "tell their story." Participants were recruited through personal associations and snowball sampling. The interviews were audio recorded and transcribed.



Participants ranged in age, amount of land owned, marital status, the number of children (and grandchildren) they had, and the timing of when they signed mineral rights lease agreements with oil and gas companies. In addition, there were differences in perceptions of shale development. For most, the interview happened to occur during the "honeymoon" phase of development, which means that leases had recently been signed and landowners had recently received their lease payment. For some, that payment was substantial; the highest amount received by someone interviewed was approximately \$5 million. During this honeymoon phase, no drilling had occurred and no pipeline easements had been negotiated with the interviewees and there was a sense that future payouts could be substantial.

Major themes from the data centered on (1) the money received from oil and gas companies and how to deal with it, (2) shale development and its impact on family and community life, and (3) landowners' connection to and concern about the land. Following are illustrative quotes from landowner interviews:

Dealing with the Money

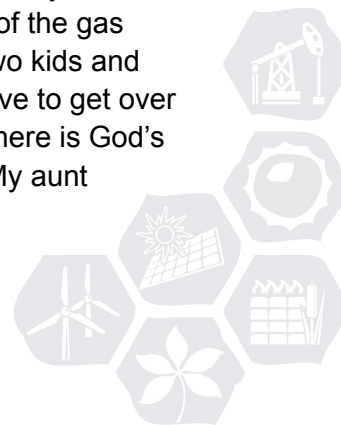
Most landowners interviewed had received a substantial lease payout. The money was often considered a good thing for them and their family, although most stated that because of their money management skills they did not “need” the money to survive. However, dealing with the money in such a way that preserved their wealth and did not negatively impact children or grandchildren were important considerations. One landowner said:

We’ve already established a trust. We have age limits on how much they can get at a certain period of time. They can do what they want to do, obviously after we’re gone, 10% of it goes to charity; no matter how much is in there, 10% is gone. Once we start getting royalties and we’re assuming that will happen, I’m sure we will do things differently too; like set up maybe different foundations and things that the money can be used for because we don’t know what all this is going to be worth. Once again, we certainly don’t think that a lot of money being given to someone without earning it is a good thing.

Impact on Family and Community Life

A few landowners expressed concern over increased truck traffic and the impact that it has had on local infrastructure and on the safety of the roads. In fact, one landowner family stated that they had recently sold their farm in the county and were moving out of state to avoid such traffic. In addition, landowners were afraid that long-time friendships with neighbors might turn into animosities and jealousies due to imagined inequities in monetary distribution. Others expressed concerns about the impact shale development and the money involved would have on family relationships. When the interviewer asked one landowner about the process of negotiating with her two sisters, she related the following:

It went smoothly in that it’s very clear that Barbara and I only have 25% interest in the land and my aunt had bequeathed 50% interest to my sister Judy since she was the goddaughter and that’s just the way it’s been. We could get all bent out of shape, but this is what it is. I think, I myself have a more emotional attachment to the farm house and the barn and the 3 acres, the home place that my sister Judy owns 100% of and to me—because it needs a lot of work—100% of the gas money should go to that plot. But she has a husband and two kids and she doesn’t see that. She sees that as a money pit and I have to get over that. There is my business and there is their business and there is God’s business and that house and the barn is not my business. My aunt Phoebe gave it to Judy for whatever reason.... My mom hates to see the barn and the home she grew up in fall into disrepair. Both of us together have kind-of let go of it. It’s Judy’s business. Judy has been paying the taxes.



Connection with and Concern for the Land

There was a strong connection to the land and a concern for its care. This was expressed most strongly by landowners who had made their living from the land and by those whose children had grown up on the land. There was an emotional connection to the land as if the land were a benevolent parent who had taken care of these families. Many farm families had even made improvements to their land or their family's farm business as a result of lease payouts. One family had established a trust with "little comments in there that we think they [our children] should always hold onto the land." Another landowner stated:

These old men that own this one place where the pipeline is [going in is] just tearing everything up; I don't know what they think. If that was my farm, there is no way they would do that to my farm for any amount of money. They are three old men, and ... they were complaining to one of the neighbors one time about [how] they went on their 4-wheeler up to this well pad and they were watching. Somebody from [the oil and gas company] told them to get the hell off; they weren't to be on that place. I thought, "Any time that anybody comes on my farm and tells me to get off any place that I own, it would be a cold day in you know where." It's just like one neighbor. They paid him for 3 acres of land for this well pad [and] they have taken a whole field. He was complaining about it to them one day [and] they got real nasty with him. They would not do that with me. There's no way.



Environmental Indicators - Marcellus/Utica Shale Energy Development



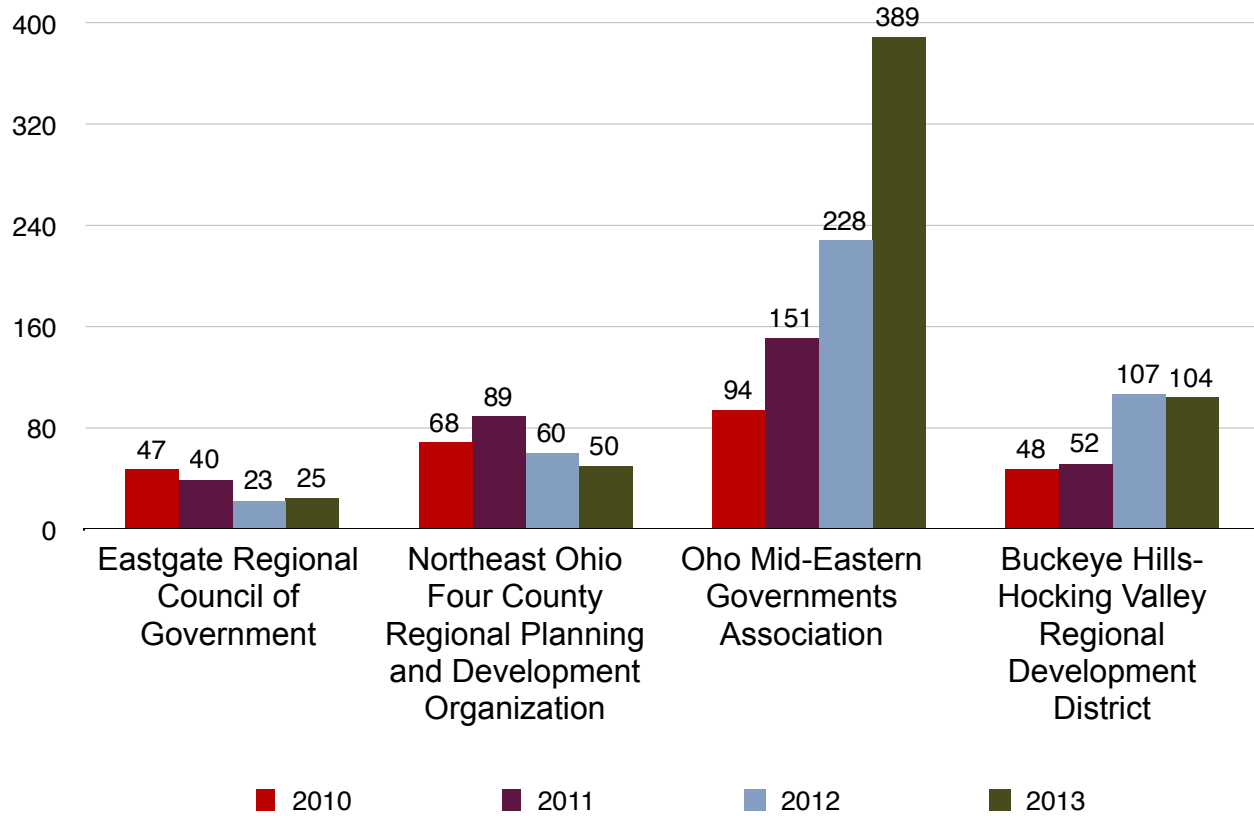
The shale oil and natural gas boom in the Utica and Marcellus shale plays has the potential to positively impact the economies of communities in the Appalachian region of Ohio. However, as with any industry based on resource extraction, there will also be associated environmental impacts. The development of the shale energy industry involves land use changes for drilling, pipelines, and processing facilities; water use for hydraulic fracturing and processing facilities; air emissions from heavy vehicles, diesel power plants, flares, and leaking transmission lines; and waste management issues, including the disposal of drilling mud, naturally occurring radioactive materials, and flowback water from hydraulic fracturing. These activities have the potential to negatively impact water quality, air quality, and habitat. While it is difficult if not impossible to accurately assess the full range of environmental impacts directly attributable to oil and gas extraction, transport, and processing activities in the region, we have attempted to identify several indicators that can provide some measure of environmental impact over time.

Wells Drilled

Extraction of oil, natural gas, and natural gas liquids requires drilling thousands of feet down to the Marcellus and Utica shale layers and then horizontally for up to a mile through those layers. While drilling technologies and techniques have advanced greatly in the past few decades, drilling operations still have an impact on and around the drilling site. One indicator of the potential for impacts from drilling operations is the number of wells drilled in a county or region. Chart 13 below is comparing the number of wells drilled in four regions included in the Marcellus and Utica shale plays between 2010 and 2013.

Clearly, there has been a significant increase in the number of oil and gas wells drilled in the region since 2010. However, we emphasize that the existence of well drilling operations in the region is merely an indicator of the potential for associated environmental impacts and that actual environmental impacts, including air emissions, spills, and noise may vary significantly from one drilling operation to the next. Note also that drilling operations for a single well may only last a few weeks, though drilling operations may last much longer at any given site if multiple wells are drilled on a single pad.

Chart 13: Number of Wells Drilled in Each of Four Regions of Ohio (2010-2013)



Well Permit Violations

Every oil and gas well drilled in the state of Ohio must be permitted by the Ohio Department of Natural Resources. Each permit includes a wide range of requirements related to reporting, safety, and environmental protections. If a drilling operation is determined to be falling short on any of these requirements, an ODNR inspector will send the well owner a notice of violation, with information about the reason for the violation and what the company must do to be in compliance with their permit. Reasons for notices of violation range from brine and oil spills to failure to notify ODNR of commencement of drilling activities. The charts below (14 and 15) show the total number of notices of violation for wells in each region, broken down by type of violation, for 2010-2014. Note that there were no violations reported for the other two regions (Eastgate Regional Council of Governments or Northeast Ohio Four County Regional Planning and Development Organization) during this time period.

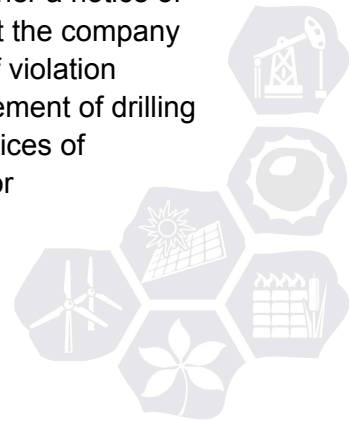
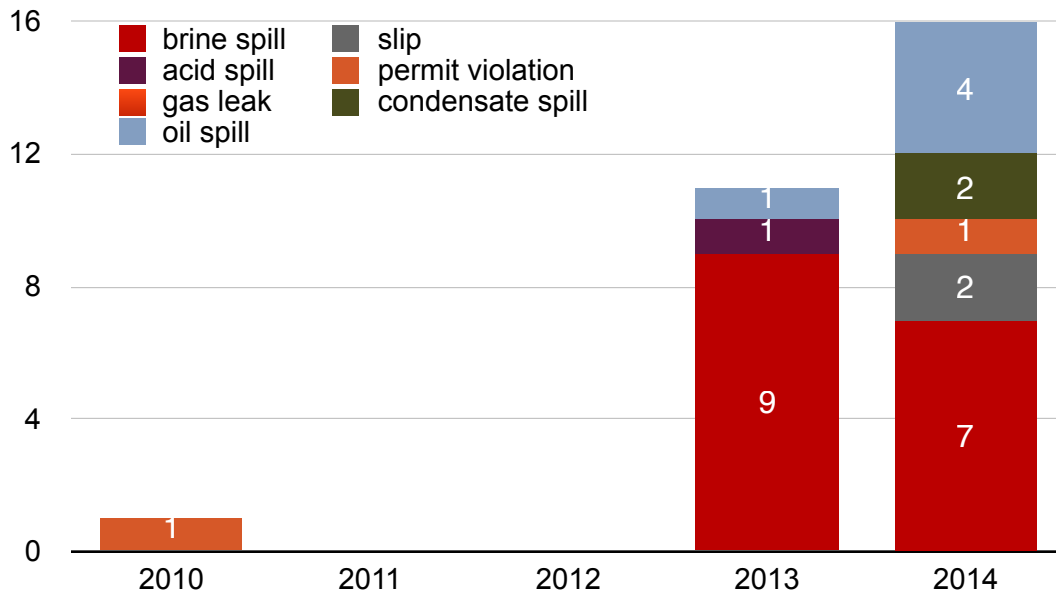
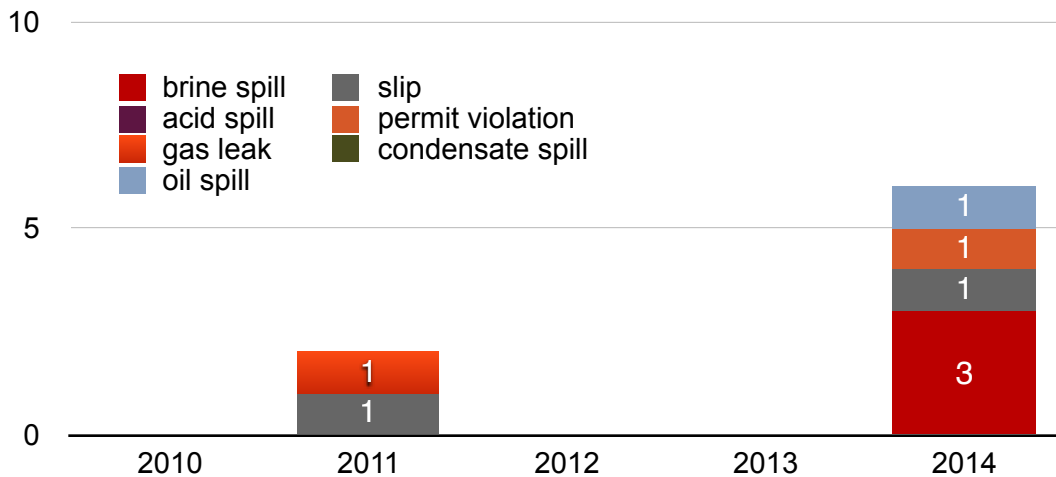


Chart 14: Environmentally Related Drill Permit Violations by Type in the OMEGA Region 2010-2014



Number of drilling permit notices of violation issued by ODNR Division of Oil and Gas Resources in the OMEGA region from 2010-2014 broken down by type of violation.

Chart 15: Environmentally Related Drill Permit Violations by Type in the Buckeye Hills-Hocking Valley Regional Development District 2010-2014

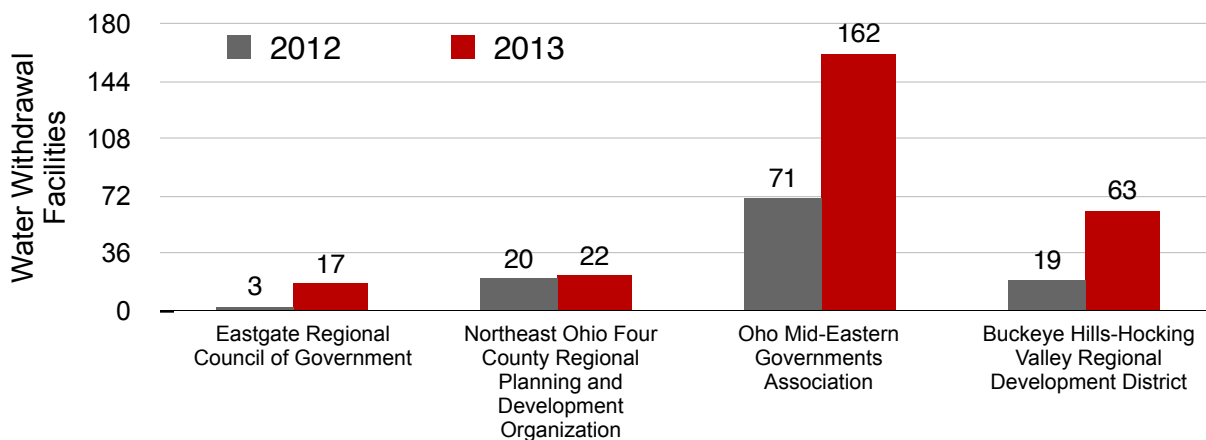


Number of drilling permit notices of violation issued by ODNR Division of Oil and Gas Resources in the Buckeye Hills-Hocking Valley Regional Development District from 2010-2014 broken down by type of violation.

Water Withdrawals

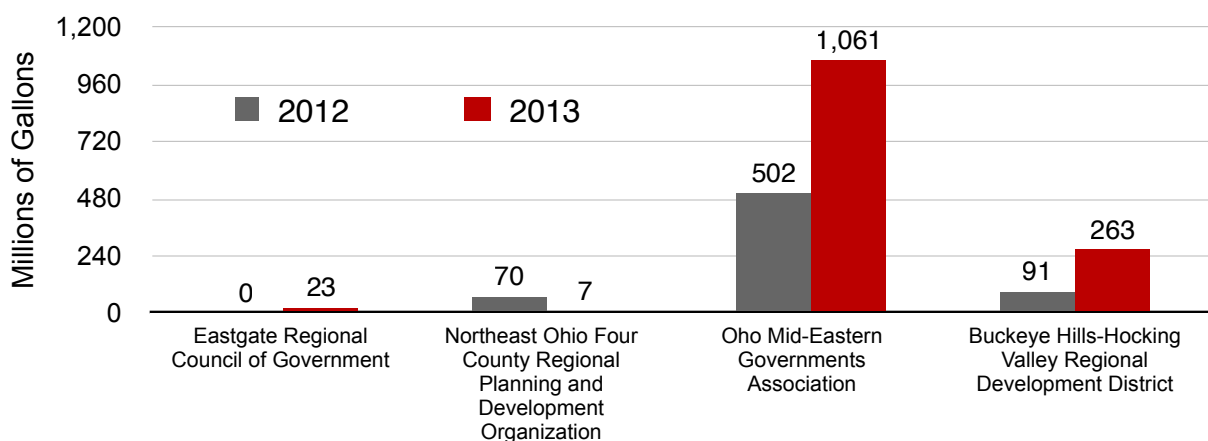
Hydraulic fracturing involves pumping water, sand, and chemical additives (primarily lubricants and biocides) into the shale formation under very high pressures in order to facilitate extraction of oil and gas. Hydraulic fracturing of horizontal wells in the Utica and Marcellus shale formations generally requires several million gallons of water. This water is generally obtained from surface waters (reservoirs, rivers, or streams) via temporary pumping facilities established specifically for this purpose. While the amount of water being extracted from a particular source may be very small in relation to the total volume in the source water body, there is a potential for localized impacts from water withdrawals, particularly when taken from small streams, if the amount and rate of withdrawal is significant relative to the natural flow rate. The following tables show changes in the number of registered water withdrawal facilities (Chart 16) and reported water withdrawals for hydraulic fracturing (Chart 17) by region from 2012 to 2013.

Chart 16: Number of Water Withdrawal Facilities per Region



Number of water withdrawal facilities registered by region for 2012 and 2013.

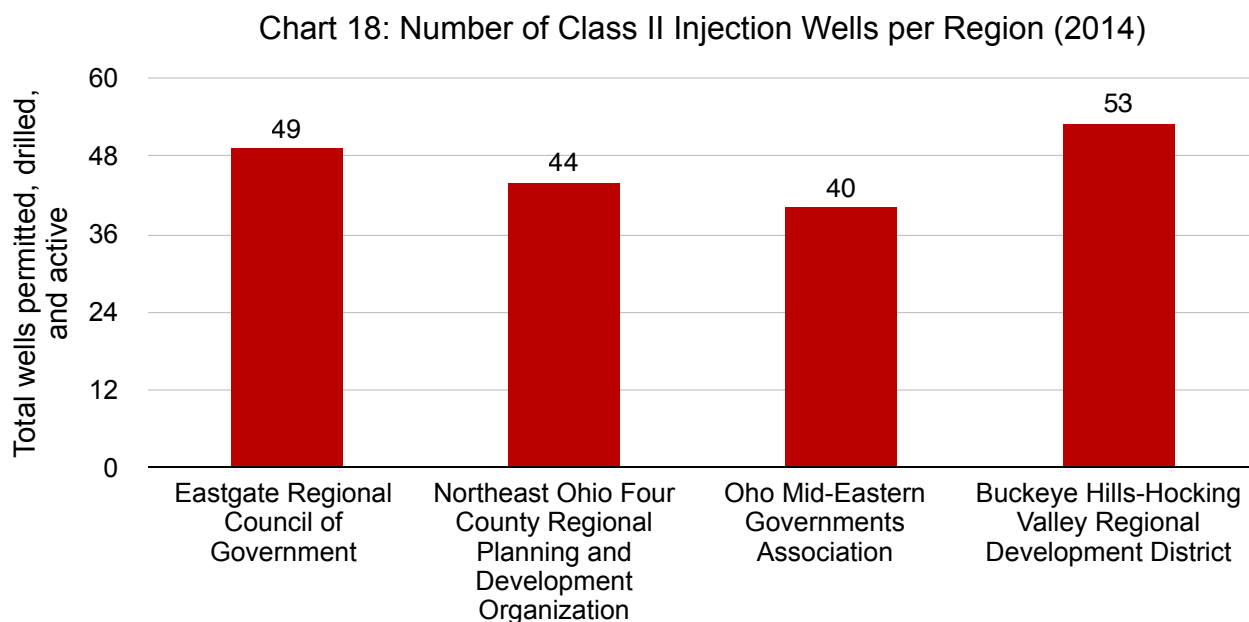
Chart 17: Water Withdrawn per Region (millions of gallons)



Total water withdrawal by region for 2012 and 2013.

Class II Injection Wells

During and after the process of hydraulic fracturing, some percentage of the hydraulic fracturing fluids and contaminated water from the shale formations flows to the surface through the well bore. These fluids, typically referred to as brine because of their high salt content, must be disposed of as a waste product. In Ohio, brine waste from drilling operations is disposed of by pumping it under high pressure into deep geologic formations many thousands of feet below the surface. These deep injection wells are referred to as “Class II” injection wells and are regulated by the Ohio Department of Natural Resources. In rare instances, deep injection wells have been associated with seismic activity (tremors), but in terms of environmental impacts, the existence of Class II injection wells are probably more important as a waste management facility where there is likely to be higher levels of traffic of heavy trucks carrying brine and wastewater from hydraulic fracturing with the associated risks of accidents or spills during the transport and transmission of fluids into the well. Chart 18, below, shows the number of Class II Injection Wells by region in 2014.



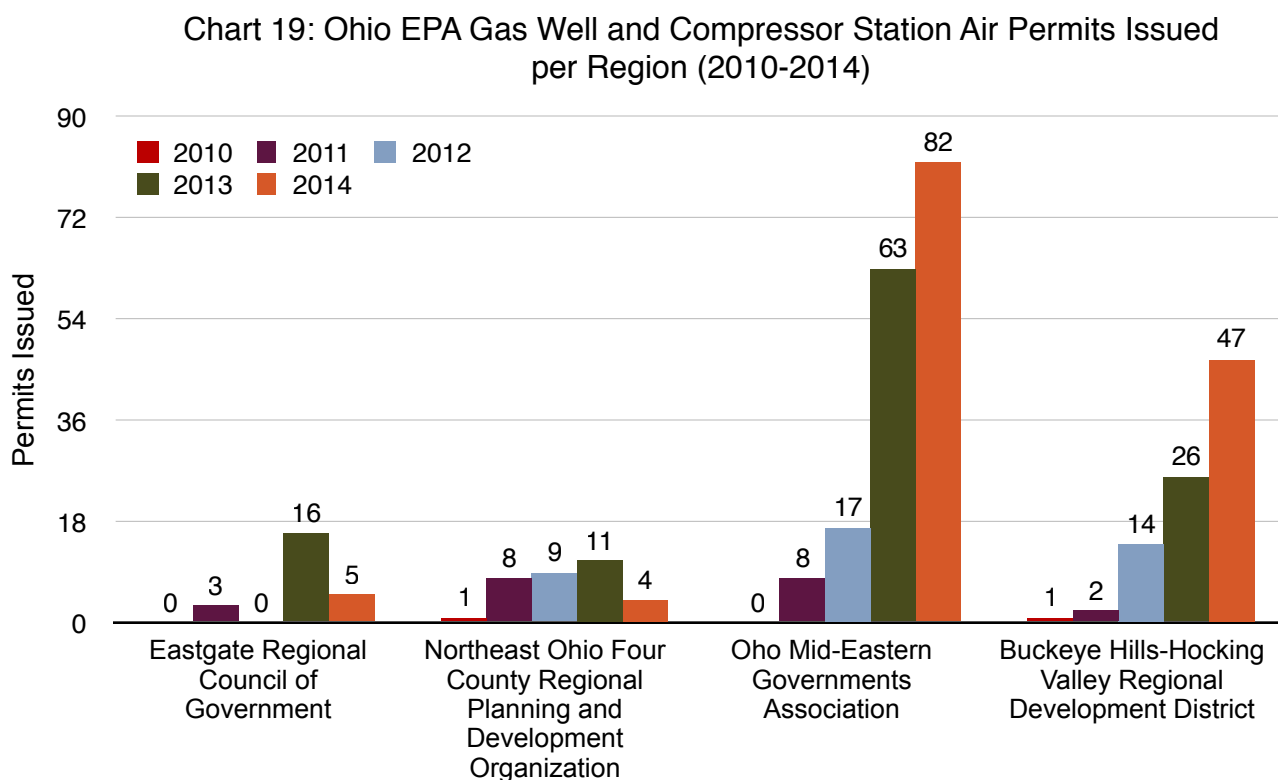
Total number of active Class II injection wells operating in 2014 by region.

Air Emissions Permits

The Ohio Environmental Protection Agency (Ohio EPA) issues general permits for the installation and operation of equipment (e.g., dehydration systems, internal combustion engines, flares, ancillary equipment, and storage tanks) located at oil and gas wells during the production phase that can emit certain air pollutants. All of this equipment can produce air pollutants regulated under the National Emission Standards for Hazardous Air Pollutants.

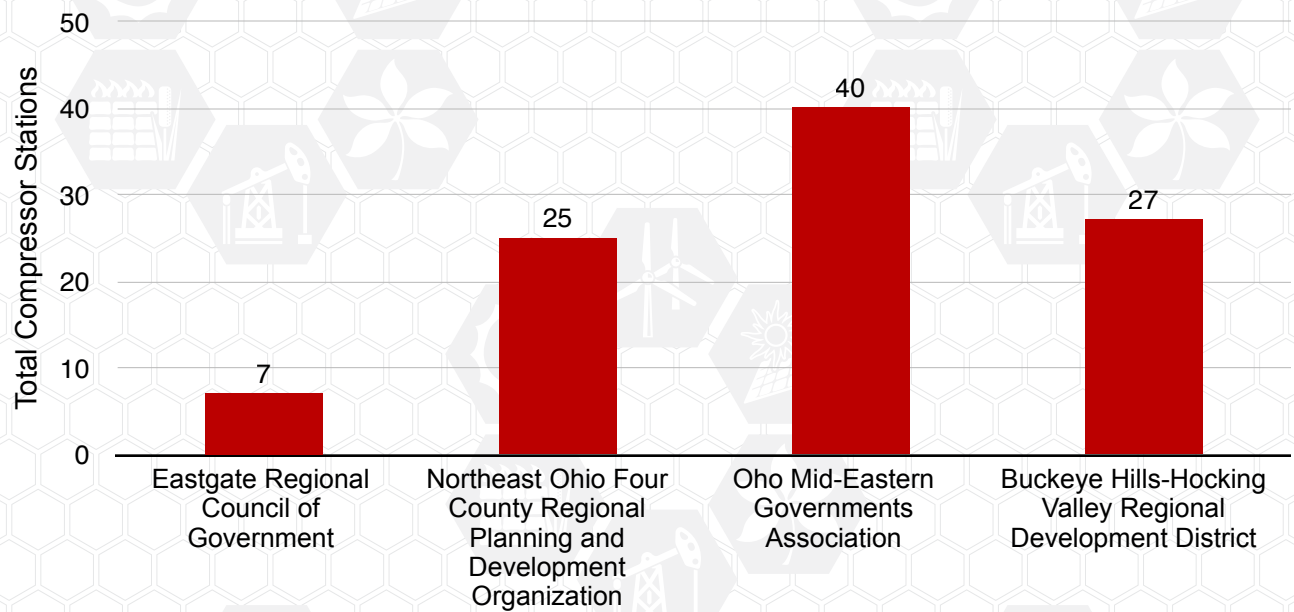
Compressor stations can also be a source of air pollution and are required to have a permit from Ohio EPA. These facilities typically have large engines used to force gas through pipelines. They may also have gas processing equipment used to remove certain products or contaminants from the gas stream.

Charts 19, 20, and 21 show the numbers of general air permits for oil and gas well sites and compressor stations in the four regions, number of compressor stations in the four regions, and top five counties by number of compressor stations, respectively.



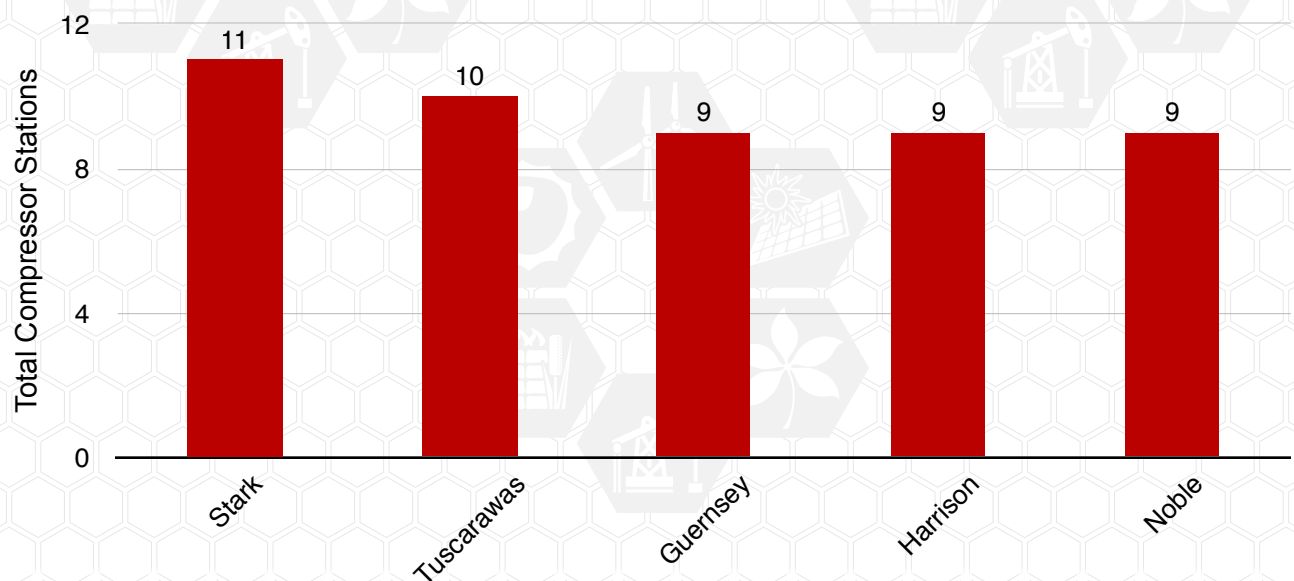
Total number of oil and gas well and compressor station general permits issued by Ohio EPA in each of the four regions from 2010-2014.

Chart 20: Compressor Stations Permitted by Ohio EPA per Region



Total number of compressor stations permitted by Ohio EPA in the four regions as of 2014.

Chart 21: Top 5 Counties by Number of Compressor Stations



Top five counties in Ohio by number of compressor stations located within the county.

Summary

The extraction, transport, and processing of shale oil and gas will have some impact on the environment. In most cases, the data needed to quantify direct impacts on soil, air, water quality, and habitat are not collected systematically, making a conclusive, comprehensive assessment of environmental impacts of the oil and gas industry on the region challenging. What we can conclude from the data provided in this report is that drilling activity has greatly increased in the region between 2011 and 2013 with a corresponding increase in the potential for associated impacts from drilling activities, as reflected in an increase in the number and types of drill permit violations reported by ODNR.

Water withdrawals from streams and reservoirs have also increased markedly during this time, which has the potential to impact aquatic life, particularly in smaller streams. Wastes are generated as a result of drilling and hydraulic fracturing. There are currently 186 Class II injection wells in the four regions available for the disposal of brine and hydraulic fracturing fluids that return to the surface during and after the hydraulic fracturing process. The numbers of facilities (oil and gas wells) permitted by Ohio EPA for air emissions has also increased significantly over the past five years, as have the number of compressor stations. We do not have data on actual hazardous air pollutants produced by these facilities, but it is safe to assume that some emissions are produced at these facilities.



Environmental Data Sources

- All data for numbers of oil and gas wells, drilling permit violations, and Class II injection wells was provided by the Ohio Department of Natural Resources Division of Oil and Gas Resources Management.
- Data on water withdrawals was provided by the Ohio Department of Natural Resources Division of Soil and Water Resources.
- Data on oil and gas well and compressor station air emission permits was provided by the Ohio Environmental Protection Agency's Division of Air Pollution Control.

References

Farren, M., Weinstein, A., and Partridge, M. (2012). *Making Shale Development Work for Ohio*. [Policy Summary Report]. Columbus, OH: Ohio State University. Retrieved from: http://aede.osu.edu/sites/aede/files/publication_files/Making%20Shale%20Development%20Work%20for%20Ohio%20June%201.pdf

IMPLAN Professional Version 2.0 Users Guide. 2004. Minnesota IMPLAN Group, Inc. (4th Edition). *The IMPLAN Input-Output System*. 2003. Minnesota IMPLAN Group, Inc.

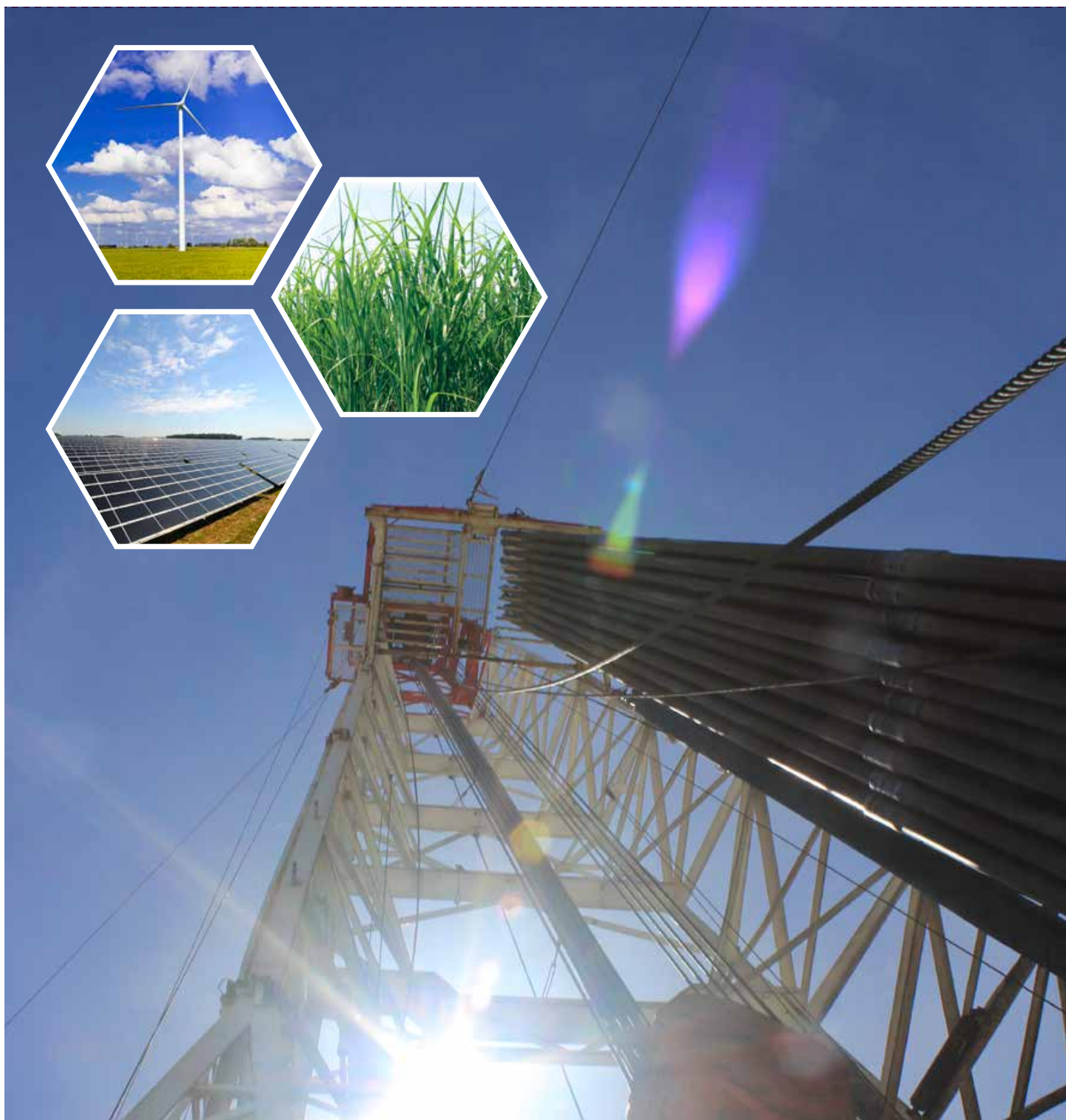
Lendel, I. (2014). Social impacts of shale development on municipalities. *The Bridge*, 44, 2. Retrieved from <https://www.nae.edu>

StatsAmerica, 2015; Indiana Business Research Center (IBRC), Indiana University Kelley School of Business. Retrieved from <https://www.statsamerica.org>.

Theodori, G. L. (2009). Paradoxical Perceptions of problems associated with unconventional natural gas development. *Southern Rural Sociology*, 24(3), 97–117.

United States Department of Energy, Energy Information Administration (USDOE/EIA). (2014). *The Annual Energy Outlook 2014*. United States Department of Energy, Energy Information Administration, Washington D.C.

Wynveen, B. J. (2011). A thematic analysis of local respondents' perceptions of Barnett shale energy development. *Journal of Rural Social Sciences*, 26(1), 8–31.



THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

Please contact us for more information:

740-725-6317 or energizeohio.osu.edu

CFAES provides research and related educational programs to clientele on a nondiscriminatory basis. For more information: go.osu.edu/cfaesdiversity.