

Economic Realities of Shale Gas Development in New York State February 2014

Submitted to accompany verbal testimony presented at Feb 4th Public Forum
Hosted by Senator Tony Avella, Albany, New York, titled
“Economic Realities of Hydrofracking”

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Key Points

- The oil and gas industry exaggerates estimates of economic benefits that will result from shale gas development, an open secret for years.
- Equally apparent, the oil and gas industry disregards shale gas development’s important and significant economic costs to communities and states.
- Recent evidence and research confirms yet again the exaggeration of benefits and disregard of costs.
- Among the many staggering costs ignored by the industry are air pollution and health costs, road damages, increased demands on police, fire, and first responder services suffered by municipalities, declines in property values, and the deterioration of industries crowded out or otherwise incompatible with an industrial landscape and/or the risk of water, air and land contamination.
- Recent research at Cambridge University indicates that by 2020 fracking firms in the UK should pay 6 billion pounds (close to \$10 billion) per year to compensate for the impact of both CO₂ and methane released into the atmosphere from gas production and burning, based on a low methane leakage rate of only 2%. This is lower than most estimates, strongly suggesting substantially greater actual costs.
- Peer-reviewed research estimates that fossil fuel pollution in New York State alone causes about 4,000 annual premature deaths, with a cost to the state of about \$33 billion per year.
- The promised boom has not materialized in Pennsylvania, West Virginia and Ohio, the only three states on the Marcellus Shale that have allowed shale gas development, as predicted by the author and confirmed by recent empirical evidence.
- Various industry-friendly groups and consulting firms, understate or completely ignore the downsides of shale gas development and exaggerate the upsides. These are in marked distinction to findings of independent, unbiased researchers, many of whose results have been published in peer-reviewed journals.
- Estimates of the amount of recoverable shale gas reserves and employment impacts that will result from exploration and production vary widely.
- The variance in employment impact estimates is attributable the methodology used to estimate the impacts, as well as the widely varying estimates of recoverable gas.

- The amount of economically and technically recoverable reserves of shale gas in New York State is far less than claimed by industry and assumed by the DEC, according to an independent group which includes a geologist, a systems engineer and two retired oil and gas industry executives.
- The total number of jobs to be created in NYS ranges from 960 to 6400, based on new estimates of recoverable shale gas in NYS, and using job creation experience in comparable geological Pennsylvania counties.
- The DEC estimated that at maximum build out in year 30, the number of jobs created will range from 13,491 to 80,510, far higher than 960 to 6400.
- The DEC estimated that in its high development scenario, annual employee earnings and personal tax revenue to the state would be \$3,711.3 million and \$185 million, respectively. These estimates are in stark contrast to employee earnings and personal tax revenue that would result if the new potential gas estimates are correct, namely \$295.22 million per year and \$14.7 million per year, respectively.
- NYS DEC has not done the work necessary to provide accurate, unbiased estimates of economically recoverable shale gas reserves and accurate, unbiased estimates of all likely economic impacts, both benefits and costs.
- It is technologically feasible for NYS to transition to a 100% renewable energy infrastructure for all purposes, but political will and private capital are needed. Governor Andrew Cuomo was wise to create the Green Bank, but more is needed. Production and use of fossil fuels, including shale gas, must be reduced and investment, instead, be directed to renewable energy and conservation.
- Natural gas has a history of extreme price volatility, which is likely to continue, while the prices of wind, water and sunlight as inputs into an energy system based on renewable energy will always be zero.
- New York State's conversion to a wind, water and solar energy infrastructure will reduce air pollution, reduce health costs associated with mortality and morbidity, protect other important industries, improve national security, set an example for other states to work toward reducing the costs of global warming, and it will create many jobs, jobs for New Yorkers.
- If NYS would commit to the WWS plan, 4.5 million jobs would be created during construction and approximately 58,000 permanent annual jobs thereafter for energy facilities alone developed as part of the plan. That is 58,000 permanent ongoing annual jobs, more than even the 53,969 jobs estimated in the SGEIS for only one year, the year of maximum build out in the average development scenario. And of course, earnings and personal tax receipts to the state would be correspondingly much larger than those derived from shale gas development.

Background

As a threshold matter, I have been examining the economic impact of shale gas development for over five years. I have written, lectured and testified extensively on this subject. I have no financial ties to the gas industry or to any environmental organization, and I have accepted no compensation for my work on this subject. Several of my papers, including a peer-reviewed article, are referenced at the end of this report [1-12]. Many of them can be found at www.catskillcitizens.org/barth. I will provide pdfs of selected papers upon request. A short bio is provided after the references.

My principal findings, even in my earliest papers on the subject, were and remain that estimates of potential economic benefits from shale gas development, and in particular job creation, in New York State have been exaggerated and that significant negative economic impacts have been ignored. I have emphasized repeatedly that there has been no adequate, unbiased assessment of economic impact for New York State and that the net economic impact to New York State from shale gas development is likely to be negative.

As I have repeatedly written and testified, extractive industries, including shale gas development, are characterized by boom and bust cycles, rendering the claim of future job creation misleading. I do not dispute that some short-term jobs will be created, but they will disappear when the industry inevitably leaves. And, typically these short-term boom industries will come into an area and attract workers from existing small businesses, forcing the small businesses to close. The shale gas industry will create an industrial landscape in formerly rural, pristine and economically diverse areas. Existing industries that are vital to upstate New York, such as tourism, agriculture, organic farming, wine and beer making, hunting, fishing and other outdoor recreation, are likely to decline as these industries are not compatible with an industrial landscape or with a real or perceived threat of water, air and land contamination.

Reports issued by various gas industry-friendly groups and consulting firms, including the Manhattan Institute, the Public Policy Institute, the Empire Center for New York State Policy, IHS Global Insight and National Economic Research Associates, understate or completely ignore the downsides of shale gas development and exaggerate the upsides. These are in marked distinction to findings of independent, unbiased researchers, many of whose results have been published in peer-reviewed journals. I have critiqued reports from each of the above named industry-friendly organizations [6,7,8,9] without meaningful response, let alone challenge.

Empirical Evidence Regarding Shale Gas Experience Elsewhere

Reports from the three Marcellus Shale states that have allowed drilling are not rosy.

A report from West Virginia, **“The Emperor Has No Gas Boom,”** shows that the expected “game changing” gas boom has not materialized there. Four years of shale gas drilling created only 916 jobs in West Virginia. “And the severance tax that was expected to produce tens of millions of dollars in new revenue has not grown at all.” The unemployment rate in the four core drilling counties has risen from 4.4% to 6.9% since drilling began and their workforces have declined in size [13].

Just a few weeks ago in Ohio, the Columbus Dispatch published a report titled, **“Fracking: So Where’s the Economic Boom that was Promised?”** This report states,

Oil and gas industry officials predicted in September 2011 that the growing effort to tap oil and gas in the Utica shale would lead to more than 200,000 new jobs in four years. So far, that has not panned out, even in the counties with the most drilling activity. For example, Carroll County’s job market is still below pre-recession levels based on two key measures. In November, the county had 12,800 employed residents and an unemployment rate of 7.6 percent, according to the Bureau of Labor Statistics. In November 2007, the county had 13,100 employed residents and an unemployment rate of 5.7 percent [14].

And from Pennsylvania, the Philadelphia Inquirer reported in September, **“PA Fracking Boom goes Bust”** [15].

In several of my writings, I have discussed economic impacts on Texas counties in the Barnett Shale, where shale gas drilling has been going on for over a decade [1,4]. According to the Texas Railroad Commission, which is responsible for regulating mineral extraction in Texas, there are four core gas-drilling counties in the Barnett Shale. They are Denton, Johnson, Tarrant and Wise Counties. Although there are many reasons for differences between county data and state data, and changes and trends in the data, and a comprehensive analysis should be conducted prior to making any definitive conclusions, it is interesting to compare the economic health of the people in the four core Barnett Shale counties to the economic health of the state as a whole. When unemployment rates, growth of median household income, and the number of people in poverty are considered, it appears that the Barnett Shale core counties are not doing better than the rest of the state. For the period from 2003 to 2010, median household income increased by 21.2% in the state of Texas, but in the four core counties, median household income only increased between 10% and 16% in the four core Barnett shale counties. For the same period, the increase in the average unemployment rates for the four core counties (2

percentage points) was a little higher than the increase in the state unemployment rate (1.5 percentage points). Finally, the number of people in poverty in these four shale counties increased, in percentage terms, just as much as statewide. Thus, considering the number of people in poverty, the unemployment rate and median household income growth, gas intensive counties in Texas do not appear to be doing well compared to the statewide figures. (Sources of Data: U.S. Census Bureau, Small Area Estimates Branch; and Bureau of Labor Statistics)

A report by the Empire Center for New York State Policy touts shale gas development and focuses on changes in per capita income in a few Pennsylvania counties. I commented as follows [8].

The Empire Center authors focused on per capita income. Per capita personal income is calculated as the total personal income of the residents of a state (or county) divided by the population of the state (or county). This is a curious choice of economic indicators on which to focus, given that in a small, poor county, per capita income may increase dramatically if only one large landowner hits the jackpot with gas lease royalties, hardly a benefit for the general population of the county, but it suggests why a shale gas supporter would find it a useful basis for rosy economic conclusions.

A closer look at per capita income is equally revealing. Averaging the growth in per capita income across the eleven Pennsylvania counties with more than 100 wells each, it appears that the increase over the four-year period from 2007 to 2011 was 15.6 %. Included in this average is a serious outlier. It is Greene County, which shows an increase on the order of 31.7%. All statisticians know how properly to deal with outliers. In this case, if Greene County is simply omitted from the analysis (and I'll mention more on Greene County below), the average increase in per capita income across the remaining ten counties was 14%. Comparing this average increase in per capita income to the average increase in per capita income in the New York State counties included in the Empire Center's report, the New York State counties averaged a higher growth in per capita income at 14.8%. To be completely fair for comparison purposes, if we omit the New York county with the highest growth in per capita income (Yates County), the average increase was 14.5%, still higher than the Pennsylvania counties, each with over 100 shale gas wells. If we include only the five counties in Governor Cuomo's New York State sacrifice zone (Broome, Chemung, Chenango, Steuben, Tioga), the increase for the same time period was 14.2%. Thus, growth in per capita income has been no better in the gas intensive Pennsylvania counties than it has been in New York State Marcellus counties without gas drilling.

In order to get a feel for how the overall population of a county is affected by shale gas development, unemployment rates and the percent of the population in poverty are better indicators. Again, per capita income in a small and/or low-income county can be skewed if just one landowner makes a killing on a gas lease. I said I would mention Greene County, Pennsylvania again. Greene County was the subject of a case study titled "Pollution Unchecked" in which it was described it as "a predominantly low-income Appalachian community in the southwestern corner of Pennsylvania, [that] suffers from serious air and water pollution." ["Pollution Unchecked: A Case Study of Greene County, Pennsylvania," Natural Resources Defense Council, December 2004.]

This was written in 2004, years before fracking came to the area. More research is required to confirm why Greene County is such an outlier with respect to growth in per capita income between 2007 and 2011, but it is quite possible that one or two landowners with gas leases skewed the result, as would a population decrease because of shale gas extraction.

Because New York State has a long history of conventional, vertical gas drilling, we can get an idea of what will happen to unemployment rates and poverty levels in New York counties if shale gas development is permitted. Some time ago, I had analyzed data for NYS. I looked at the top ten gas producing counties in NY for the period from 2006 to 2008. The gas intensive counties were not better off than neighboring counties without gas drilling when you look at the number of families below poverty level, median household income, or unemployment rates [1,2].

Headwaters Economics [16] concluded that

counties that were not focused on fossil fuel extraction as an economic development strategy experienced higher growth rates, more diverse economies, better educated populations, a smaller gap between high and low income households and more retirement and investment income.

Freudenberg and Wilson [17] studied non-metropolitan regions, concluding that, "the areas of the United States having the highest levels of long-term poverty tend to be found in the very places that were once the site of thriving extractive industries." Recent research by Peach and Starbuck [18] found only **small** positive impacts on income, employment and population as a result of oil and gas extraction in New Mexico. And Weber, [19] focussing on the short-term impact of a natural gas boom in Colorado, Texas and Wyoming, found only **modest** increases in employment, wage and salary income, and median household income. Modest increases in

employment, income and tax revenue will not cover the large costs to state and local governments.

Omitted Costs

My article in *New Solutions* [1] referenced many research items associating high costs with shale gas development, and “A Balance Sheet for New York State: What is New York State’s Net Equity from Shale Gas Development ?” (on the next page) details the very long list of costs (as liabilities in the column on the right) and the much shorter list of benefits (as assets in the column on the left side). As more research and reports are published, the values of many of the items on the left side of the balance sheet are shown declining while the costs on the right hand side are clearly increasing.

The last paragraph in the so-called “Economic Assessment” in the SGEIS lists some of the costs, but omits any attempt to estimate these costs. Moreover, the “Assessment” makes no mention of some of the greatest potential costs to New Yorkers.

Since my article in *New Solutions* [1] was published, additional health costs have come to light.

For example, a previously ignored set of health costs associated with shale gas development result from poor pregnancy outcomes for women near shale gas development, including low birth rates and diminished Apgar scores [20]. This paper was presented at the American Economic Association annual meeting just last month.

And in a just-published study of pregnancy outcomes, researchers said that while further research is required, they “observed an association between density and proximity of natural gas wells within a 10-mile radius of maternal residence and prevalence of CHDs (congenital heart defects) and possibly NTDs (neural tube defects) [21].”

Additionally, there has been further confirmation of water contamination, both drinking water contamination and river water contamination that negatively affects fishing and other industries dependent on clean water [22]. Coauthor, Avner Vengosh said, “Years of disposal of oil and gas wastewater with high radioactivity has created potential environmental risks for thousands of years to come.” And lead author, Nathaniel R. Warner said, “While water contamination can be mitigated by treatment to a certain degree, our findings indicate that disposal of wastewater from both conventional and unconventional oil and gas operations has degraded the surface water and sediments...This could be a long-term legacy of radioactivity.”

A Balance Sheet for New York State: What is New York State's Net Equity from Shale Gas Development?

Prepared by Jannette M. Barth, Ph.D., January 4, 2012

► Assets*

Tax Revenue:	
Direct from the gas industry based on future legislation	
Increased income tax based on	
Royalty income to leaseholders	
Lease income to landowners	
Stimulation of industries based on byproducts of natural gas	
Climate benefits from decreases in green house gases from burning shale gas	
Indirect benefit to NYS from improved Balance of Payments assuming substantial shale gas exports	
Short-term job gains in the gas industry and related industries	
Increased spending by leaseholders in New York State	
Lower cost of energy as long as it lasts	
TOTAL ASSETS	???

*These are not necessarily comprehensive lists of assets and liabilities. They serve only as examples. Note that where an asset or liability is a future stream of income or expense, discounted present value should be used.

► Liabilities*

Tax Revenue Loss:	
Income tax losses by leaseholders who vacate properties and relocate out-of-state	
Income tax losses caused by decreases in tourism and other industries negatively affected by drilling	
Property tax losses caused by negative impact of drilling on property values and financing	
Decreased spending by leaseholders if they move out of state, or buy second homes out of state	
Human health costs associated with:	
Water contamination from frack fluids and wastewater	
Air pollution from compressors, leaks, gas released at well-sites	
Costs due to impacts on animals (domestic, agricultural and game) of water, land and air contamination	
Climate costs associated with increases in greenhouse gases from methane leaks and venting	
Costs associated with declining quality of life due to the creation of an industrial landscape	
Costs associated with declines in tourism industry	
Costs associated with declines in organic farming and other agriculture and food manufacturing	
Costs associated with declines in outdoor recreation	
Costs associated with increased air pollution from increased truck traffic	
Costs associated with declines in fisheries and trout fishing industry	
Infrastructure costs due to use of and damage to roads and bridges from increased truck traffic	
Costs due to declines in numbers of retirees and retirement housing market	
Costs due to declines in numbers of second home owners and second home market	
Costs due to crowding out (loss of jobs to existing businesses and governments)	
Costs to communities due to increased demand for police, fire and first responder services	
Social costs associated with the gas drilling industry	
Costs to the mortgage industry and housing market, and related declines in property values and property tax revenue	
Costs associated with increased homelessness	
Costs associated with the postponement of investment in renewables	
Opportunity costs due to the prevention of future building and economic development	
Costs associated with a long-term bust, characteristic of extractive industries	
TOTAL LIABILITIES	???
NET EQUITY	???

Is the **Discounted Present Value of Total Assets** minus the **Discounted Present Value of Total Liabilities** a positive value?
This question cannot be answered until a comprehensive risk assessment and economic analysis has been conducted.

It was very recently reported,

In at least four states that have nurtured the nation's energy boom, hundreds of complaints have been made about well-water contamination from oil or gas drilling, and pollution was confirmed in a number of them, according to a review that casts doubt on industry suggestions that such problems rarely happen [23].

M.Z. Jacobson *et al* tie fossil-fuel driven air pollution to widespread illness, lost time from work and school, and 4000 annual premature mortalities in NYS, which together cost the state approximately \$33 billion/year. In addition, “fossil fuels emitted in the state will also result in approximately \$1.7 billion in global warming costs to the US by 2025. Converting to WWS in the state will eliminate these externalities and their costs [24].”

Increased demand for social services, first responders, and police will cost communities. Jill Morrison of the Powder River Basin Resource Council in Wyoming stated that there has been a 10% to 15% increase in crime and communities have had to build larger jails [25]. Fuller, in *The New Yorker* has described increased crime and drug use in Wyoming communities with gas drilling [26].

There is evidence that in Pennsylvania's Marcellus region, “Most local governments being affected by shale gas development are not seeing more tax revenue as a result, while 26% of the local governments indicated that related costs had increased.” Kelsey and Ward [27]. And other research shows that revenue is unlikely to offset burdens to state and local governments. Dutzik, Ridlington and Rumpler [28] have listed many of the economic costs and show that communities and states will bear many of the costs.

Significant damage to roads is apparent. The Texas Department of Transportation reported that a conservative estimate of the repair costs for roads damaged by gas drilling activities is \$1 billion for farm-to-market roads and another \$1 billion for local roads [29].

A report from Cornell stated, “In Bradford County, PA, 1,000 of 1,300 miles of roads have been damaged.” “This type of road damage will lead to extraordinary monetary cost. In Pennsylvania, tens of thousands of dollars have been spent on weight limit signs alone.” And, “Arkansas State Highways have incurred over \$200 million in repair costs in the Fayetteville Shale [30].” Another report from Cornell discusses specific issues related to roads in New York State [31].

The decline in property values is a great concern, but has been inexplicably (or suspiciously) omitted from most analyses. In Texas, the Wise County Real Estate Appraisal Board decreased the value of homes by as much as 75% for properties on which a gas well sits. Research by Duke University and Resources for the Future demonstrated that the risk of ground water contamination from natural gas extraction leads to a “large and significant reduction in house prices” and that

these reductions offset any gains to the owners of groundwater-dependent properties from lease payments or improved local economic conditions and may even lead to a net drop in prices...to the extent that the net effect of drilling on groundwater-dependent houses might even be negative, we could see an increase in the likelihood of foreclosure in areas experiencing rapid growth of hydraulic fracturing [32].

Based on a survey of homeowners, it was found that proximity to fracking activity lowered bid values by 5% to 15% [33].

The economic benefits of pipeline construction are very short-term, creating a few jobs for a short period of time. Ignored is the fact that once a network of pipelines is built, including gathering lines, transmission lines and larger pipelines, future development is unlikely as one cannot build on top of or close to natural gas pipelines.

As additional unbiased, independent (i.e., not funded by the oil & gas industry) scientific and economic research papers are published, it is becoming more and more evident that New York State is unlikely to experience a net positive economic impact from shale gas development.

How About the Low Price of Natural Gas?

The industry often claims that the low price of natural gas makes the commodity attractive to end users, both residential consumers and businesses of all sizes. But the industry never points out that natural gas has a long history of price volatility and that the price may very well increase substantially due to increased demand through LNG exports, the conversion of buildings and vehicles to natural gas, and the new manufacturing plants that are currently taking advantage of low natural gas prices. When the price of natural gas increases dramatically after widespread conversion to the fuel for heating and industrial processes, all of the end users will suffer financially. The uncertainty resulting from volatility in fuel prices makes for very difficult long-term planning. I have critiqued a report by National Economic Research Associates, an oil & gas industry-friendly consulting firm, that tries to make the case that increased exports of LNG from the United States will have minimal impact on natural gas price [9].

The price of natural gas as an input to a fossil fuel based energy system will always be volatile and can be expected to increase, perhaps substantially, in the long-term. This sharply contrasts with the price of alternative fuels. The price of wind, water and sunlight as inputs into an energy system based on renewable energy, will always be zero.

All of the above confirms that we do not have a comprehensive or realistic assessment of the economic impact of shale gas development in NYS.

Shale gas development in NYS will benefit the gas industry and a few large landowners, but it is likely to be at the expense of small communities and statewide taxpayers.

Recent Employment Impact Findings

The newly formed Multi-State Shale Research Collaborative released their first report a few months ago, and it confirms my early predictions and now established findings that job creation from shale gas development is greatly exaggerated. For example, among other conclusions, the Collaborative found that Marcellus Shale drilling has had “little overall impact on the state economy in any state studied,”; “employment estimates have been overstated, and the industry and its boosters have used inappropriate employment numbers, including equating new hires with new jobs and using ancillary job figures that largely have nothing to do with drilling,”; and “industry-funded studies ...have substantially overstated the total jobs impact of the shale industry [34].”

Much of the Collaborative’s research is based on earlier work by Weinstein and Partridge [35], and in particular the Weinstein and Partridge findings that,

In Pennsylvania counties between 2005 and 2009, they found no statistically significant link between number of wells drilled and overall employment growth. The authors suggested that this may be due to the capital-intensive nature of drilling ...or the negative impact of shale [gas development] on jobs in other sectors (e.g., tourism.)

Again, this supports what many of us have anticipated for years: that there will be negative impacts on other industries in Upstate New York if shale gas development is permitted.

The Multi-State Research Collaborative extended the analysis of Weinstein and Partridge to 2012 and included the other Marcellus states in addition to Pennsylvania and found “no statistically significant link between the number of wells drilled and employment growth.”

Job creation by shale gas development has never been in question by any of the past writers on this subject, including myself. Indeed, the number is so tiny relative to that of all other jobs in the region that aggregate statistical analysis shows that the overall impact is insignificant. While industry and even the Pennsylvania governor has claimed that 200,000 jobs have been created by shale gas in the state, the Multi-State Collaborative has shown that it's about one-tenth that amount. Interestingly, the work by Weinstein and Partridge likewise had shown that job creation from shale gas development in Ohio would be about a tenth of that claimed by the industry.

Alternative Job Creation Estimates

There have been various non-industry funded attempts to estimate shale gas related job creation, and I summarize some of them here, referring to them as Alternatives 1 through 5, and comparing them below in a tabular form to show the widely varying estimates of job creation.

The job creation estimates in the DEC's SGEIS are not directly comparable to these five alternative estimates because the consulting firm employed by the DEC, E&E, developed a build-out schedule from one to sixty years, assuming that every well drilled would produce for 30 years. According to their assumptions, the maximum employment level is at Year-30 and E&E provided low, medium and high production scenarios.

It appears, based on work by Arthur Berman [36] who studied the Barnett Shale in Texas and work by Acton, *et.al.* [37], who studied the Marcellus Shale in Pennsylvania, that shale gas wells in New York are likely to produce for less than 10 years, a far shorter lifespan than assumed by the DEC. Arthur Berman, a noted petroleum geologist observed, "the average commercial life for horizontal wells is about 7.5 years, although the mode is 4 years" [36].

E&E assumed that 11.53 jobs are created for the construction of each well and that 0.17 jobs are created for each producing well annually. These are direct jobs. To estimate indirect jobs, E&E used RIMS II input-output coefficients to develop multipliers for three regions on New York's Marcellus Shale. I have previously criticized the use of input-output models for this application [1,2].

E&E used three different employment multipliers for the three different regions that they analyzed. The average of the three multipliers is 1.4202, which means that for each direct job created, E&E predicted the creation of about 1.4202 additional indirect and induced jobs.

In my efforts to compare the DEC's job creation estimates to alternative estimates from the literature, when indirect and induced jobs are not reflected in the alternative estimates, I have used an optimistic multiplier assumption of 2.0.

Alternative 1. One of the earliest estimates of job creation related to natural gas exploration and development was based on the Valle Vidal [38]. The author, M.T. Power, concluded that because natural gas development is land, capital and technology intensive, it makes limited use of human labor, thereby providing limited employment and pay opportunities. Parenthetically, this is one of the reasons that it can create such great value for the industry. Power also concluded that because natural gas development requires specialized skilled workers who by necessity must move to wherever new gas fields are under development, many of the development jobs will not be available to local residents. Further, the spillover or “multiplier” impacts on the local economy associated with natural gas development are very limited for several reasons. First, much of the natural gas is shipped out of the local economy unprocessed. Second, most of the equipment, tools and materials are specialized and must be imported into the local area from distant trade centers. Third, because of specialized workforce mobility, much of the payroll leaves the local economy, flowing to the workers’ home bases. Regarding job creation, Professor Power is more specific. He says,

The employment and payroll associated with natural gas development are associated with two distinct phases of that development: The first phase involves the actual drilling and development of the wells, including the development of the road system and other infrastructure and the necessary pipeline system to collect the gas and dispose of the water.

The second phase involves the operation and maintenance of the wells and the collection system once they are in place.

The drilling and development largely employ specialized skilled workers who move from one drilling site to another. Other construction workers are needed for the roads and pipeline infrastructure. If the employment associated with these activities over the year is divided by the number of wells developed, there is about **one job associated with the development of each well.**

The operation and maintenance of the gas field once it is producing is less labor intensive. The employment level per operating well appears to vary considerably among different areas, possibly depending on the density of the wells. In the Colorado portion of the Raton Basin, employment in oil and gas production is quite low compared to the number of wells (**0.12 jobs per well**). In the Colfax County portion of the Basin, the number of jobs per well appears much higher, **0.46 jobs per well**. In La Plata County, Colorado, employment per well is in between these two values, **0.33 jobs per well** (Emphasis supplied).

Alternative 2. Another analysis, produced by researchers at Rice University and it focused exclusively on Texas [39], estimated total job creation (direct and indirect)

is **6.4 full-time equivalent (FTE) jobs per well**. This seems extremely high, but note that the authors are affiliated with natural gas-friendly research organizations and university departments. In fact the lead author is the George and Cynthia Mitchell Chair in Sustainable Development and Environmental Economics. George Mitchell was a well known pioneer in fracking for natural gas. There is concern in Texas that the strong growth in wind energy may displace the use of natural gas, so some researchers with associations with the oil & gas industry in Texas may have an incentive to downplay the economic benefits of wind relative to shale gas.

I have addressed relative impacts on Texas and New York in some of my writings. For example,

Even if there is a large positive economic impact in Texas, comparing Texas to New York is comparing apples to oranges for the purposes of estimating economic impacts from gas drilling. Texas has a labor force with the requisite skill sets. The rural counties in upstate New York would have to import the labor, who in many cases will be temporary and transient, and most of their income will be spent in their home states (probably not in New York), greatly reducing the multiplier effect in New York State relative to Texas. In addition, Texas has a very large support industry network for oil and gas activities with all requisite machinery, equipment, etc., many of which are probably manufactured there or at least distributed and contracted for there. Note also that the major gas companies are not headquartered in New York (for example, Chesapeake Energy is in Oklahoma City and XTO is in Fort Worth). New York would have to import most gas industry services, machinery, equipment, and management, and much of this would probably come from established businesses in other states such as Texas, so it is even possible that Texas would derive greater economic benefit from drilling in New York State than would New York [1].

Alternative 3. Another estimate of job creation per well is provided by the recent analysis by the Multi-State Shale Research Collaborative [34]. Their report states,

In the region as a whole, shale-related employment grew by almost 33,000 jobs as 8,750 wells were drilled. An estimated **3.7 jobs were created for every well drilled in the six state region**. This figure stands in sharp contrast to the claims in industry-financed studies, which included estimates as high as 31 jobs created per well drilled.

Alternative 4. It may be more accurate to estimate potential New York State employment impact based on data from the comparable Pennsylvania counties rather than an entire six- state region. The Multi-State Research Collaborative report contains some county level data, including data for two of the counties considered most comparable geologically to the New York State potential drilling area, according to Acton, *et al* [37]. Based on only Tioga and Bradford Counties in

Pennsylvania, the estimate is that on average, **0.815 jobs are created per drilled well**. Unfortunately, it is impossible to obtain precise publicly available data on job creation at the county level. The Multi-State Research Collaborative chose to use a super-sector, “Natural Resources and Mining,” but according to the Bureau of Labor Statistics, this super-sector includes NAICS 11 (Agriculture, Forestry, Fishing and Hunting) as well as NAICS 21 (Mining, Quarrying, and Oil and Gas Extraction). As a result there are many jobs reflected in this county-level estimate unrelated to shale gas development. Thus, the employment levels estimated in this alternative may be somewhat optimistic.

Alternative 5. In an effort to be more precise in the county-based estimates of Alternative 4, Alternative 5 is based on data from the US Census, County Business Patterns and includes only NAICS 21 (Mining, Quarrying, and Oil and Gas Extraction). This also includes a number of jobs unrelated to shale gas development, but it has narrowed down the sector. These data include some years with disclosure issues due to the fact that the number of employees by county is too small to make public. When a category is identified in the dataset as “nondisclosed,” a range is provided. In these cases, for this analysis, the high end of the range in the disclosure category was used. (For example, if employment in one year is non-disclosed, a code is provided with the range of perhaps 20 to 99, and the number used is the highest end of the range, or 99.) Thus, these employment estimates are likely to be somewhat optimistic, affording the gas industry the benefit of every doubt. In this alternative, based on only Tioga and Bradford Counties in Pennsylvania, the estimate is that on average **0.66 jobs are created per drilled well**.

In my comments submitted to NYS DEC on the economic assessment for the SGEIS, I pointed out that the job creation estimates are highly exaggerated for a number of reasons, one of which was the assumption regarding potential gas production. The USGS and Acton, *et al*, show that the DEC’s estimate of total recoverable reserves is highly exaggerated in the SGEIS. In addition, as mentioned above, other researchers have noted that the average shale gas well produces for between 4 and 7.5 years only (not for the 30 years assumed in the SGEIS).

E&E estimated three development scenarios and the total employment impacts (direct and indirect) for the low, average and high development scenarios are summarized in the following table, along with the respective numbers of wells constructed from Year 1 to Year 30.

Note that E&E used a 60-year development and production horizon, whereby production and employment ramp up slowly from the first year, to a maximum at Year-30, and then decline through Year-60. The employment numbers in the following chart represent the maximum levels at the 30-year point.

NYS DEC's SGEIS: Wells and Employment Impact Summary

Development Scenario	Low	Average	High
Number of Wells	10,532	42,126	62,781
Employment at Year 30	13,491	53,969	80,510

Acton, *et al* [37], a concerned group of New York-based researchers, including a systems engineer, a geologist and several industry experts, has analyzed data on Pennsylvania geology, shale characteristics and shale gas production, related these data to New York State, and estimated the potential for Marcellus Shale gas production in New York State.

Changes in the price of natural gas have influenced the number of wells drilled and production, and thus shale gas related employment levels in Pennsylvania have dropped in response to lower price-induced drilling rates.

The new estimates of NYS shale gas potential by Acton, *et al* take natural gas price level into account, as shown in the following table.

New York State Shale Gas Potential Estimates at Three Price Levels

Natural Gas Price	\$4.50	\$6.00	\$8.00
Total Producing Wells	436	1769	2906
Total 10-year EUR (TCF)	0.8	2.7	4.3

There are a number of reasons why job creation estimates vary among analyses and are not directly comparable, including different assumptions used regarding number of productive years of a well's life, different assumptions in the relative proportion of producing to non-producing wells, different analytical methods, and differences among geographic regions.

Acton, *et al* reviewed detailed data from PA DEP in order to estimate the relative number of producing and non-producing wells for one county in Pennsylvania. This was done for Tioga County, PA, as they consider it comparable in geology to the likely production area in New York State. They estimated that the percentage of total wells drilled that are either "producing" or "likely to become producing" is only 56%. Thus, total wells drilled (producing and non-producing) would be 779 at \$4.50, 3,159 at \$6.00 and 5,189 at \$8.00.

Below I use the assumptions from Alternatives 1 through 5 to compare various job creation estimates. I apply them to the recent estimates of NYS Shale Gas Potential.

If shale gas in New York State is truly only economically recoverable in the small geographic area shown by Acton, *et al*, then I expect that the employment estimates of Alternative 5 are likely to be the most accurate. In this case, job creation (direct, indirect and induced) will range from 961 to 6404, corresponding to a natural gas price range of \$4.50 to \$8.00 per mcf.

The table below compares different estimates of potential job creation from shale gas development in New York State corresponding to the five alternatives described above. They are all based on the number of wells projected by the NYS Shale Gas Production Group.

The last two rows in the table are estimates using the SGEIS assumptions and industry assumptions as described by the Multi-State Shale Research Collaborative, respectively.

**Alternative Estimates of Job Creation for Three Levels of Natural Gas Price
(number of jobs)**

NG Price	\$4.50	\$6.00	\$8.00	Tech
Alternative 1	2,087	8,466	13,907	21,608
Alternative 2	4,982	20,217	33,211	51,600
Alternative 3	2,564	9,309	17,364	29,831
Alternative 4	1,207	5,153	8,465	13,152
Alternative 5	961	3898	6404	9950
SGEIS	13,802	55,998	91,990	142,923
Industry	24,136	97,927	160,868	249,938

Alternative 1. Power, 1 job per well for development and 0.3 jobs for each producing well.:

Alternative 2. Rice University, 6.4 total jobs per well.

Alternative 3. Multi-State Research Collaborative 6-state region: 3.7 jobs per well

Alternative 4. Multi-State Research, using their county level data which include NAICS 11 and NAICS 21.

Alternative 5. Barth, using CBP data for NAICS 21 only.

SGEIS: Assumed 11.53 FTE workers to construct each well and 0.17 per producing well per year.

Industry: According to Multi-State Research Collaborative, some industry claims are 31 jobs per well.

Earnings and Tax Receipts

In light of the highly exaggerated reserves and job claims made by E&E in the SGEIS, it is important for the DEC to reconsider every assumption in the SGEIS. For example, the distribution of income across different jobs related to shale gas development should be analyzed in detail to ensure that estimates of earnings per worker, earnings per year and personal income tax receipts to NYS are accurate.

Giving E&E the analytical benefit of the doubt here, in estimating earnings and income tax revenue that would result from the job estimates from Alternative 5, I applied the E&E proportion of earnings per job, and I thereby implicitly adopted E&E's assumption of the distribution of income across all jobs.

Employment, earnings and personal tax revenue projections based on the NYS Potential Gas estimates are summarized in the following table.

Alternative 5. Employment, Earnings, Tax Receipts

Development Scenario	Low	High
Employment	961	6,404
Earnings/year (millions)	\$44.29	\$295.22
Personal Tax Revenue (millions)	\$2.2	\$14.7

Each estimate is far less than those found in the DEC's SGEIS.

Total number of jobs per year at the maximum (30-year) as estimated by E&E is 13,491 in the low development scenario and 80,510 in the high development scenario. Corresponding employee earnings per year are \$621.9 million and \$3,711.3 million, respectively. In turn, personal tax revenue to New York State, as estimated by E&E, is \$31 million and \$185 million per year for the low and high development scenarios, respectively.

Even the lower estimates (of Alternative 5) are optimistic as they assume that jobs go to individuals who pay taxes in New York State, while in reality, the shale gas industry is known for its transient workforce. E&E assumed that at first, 77% of the total workforce would be transient workers from outside the state, and by Year-30, they assumed that 90% of the shale gas workers would be hired locally. Findings from Pennsylvania indicate,

The early stages of development found as many as 70-80% of employees were from outside Pennsylvania. Although there is still tremendous variability across energy, service, and support companies, based on recent interviews and survey data the percentage of new industry hires who are Pennsylvania residents

today ranges from 50- 100% with an approximate average of 65-75% of new Marcellus workers being Pennsylvania residents [40].

If Acton, *et al* are correct that only a very small portion of New York State would be productive, and if they are correct that this small productive area is on the Pennsylvania border, then it is possible that close to 100% of the shale gas workers would be from states other than New York.

E&E correctly pointed out that tax revenue directly from the gas companies will be minimal in New York, stating,

given the many benefits in the New York State tax code for energy companies, such as expensing, depletion, and depreciation deductions, the taxable income from the natural gas industry would be greatly reduced. In addition, New York State offers an investment tax credit (ITC) that could substantially reduce most, if not, all of the net income generated by these energy development companies. Also, the sale of the natural gas generated by these companies may not take place in New York and, therefore, may not be subject to New York State corporate tax (NYS DTF 2011a).

If the new shale gas potential estimates are accurate, then the ad valorem tax revenue to local governments in shale counties would be far less than that projected by E&E in the SGEIS. Shale gas supporters frequently claim that the ad valorem tax will result in generous tax revenue to localities. There are many uncertainties regarding the ad valorem tax as it applies to shale gas development. When one considers the potential costs that may be incurred by local communities, it is far from clear that the ad valorem tax will be sufficient to pay the increased community costs, increased public health costs and mitigation of the environmental impacts. It is clear that the ad valorem tax will not cover costs to communities early in the drilling process as the tax starts to be collected several years after production starts. There will be substantial costs to communities prior to the collection of the ad valorem tax, and small upstate communities lack excess cash to cover such costs. It is uncertain whether the discount rates used to calculate the tax are appropriate in the high risk case of horizontal high volume slickwater hydraulic fracturing. The gas industry is not required to take into account the very real and very significant risks and costs to the public.

We know that in 2009, local governments in New York State received on average approximately \$600 in tax revenue from each producing oil and gas well. ("New York State Oil, Gas & Mineral Resources 2009," NYS DEC Division of Mineral Resources) The costs to communities that will result from horizontal high volume slickwater hydraulic fracturing are likely to far exceed this.

The major beneficiaries of shale gas drilling (i.e., the gas companies and the few landowners who benefit) must be taxed at a high enough rate, and early enough in

the process, to pay for the negative externalities inherent in gas development. As Nobel Prize winning economist Joseph Stiglitz stated on National Public Radio, “we are almost giving away our oil and gas.” (WNYC, December 19, 2011)

If the gas companies and landowners were taxed on the basis of negative externalities and negative externalities were incorporated into the industry’s cost structure, then the true cost of shale gas would be reflected in business decisions, and it is highly unlikely that shale gas development would be pursued.

Is There an Alternative to Shale Gas for the NYS Economy?

My earlier writings have cited numerous articles and reports that show that many communities with extractive industries, including shale gas development, have not experienced the positive economic impacts that were desired. These communities instead have experienced negative impacts associated with the well known “resource curse” and with the boom and bust cycle typifying extractive industries. In New York State, if the most recent estimates of potential shale gas reserves are correct, we may experience all of the negative and none of the positive impacts, as job creation would be far smaller than the DEC claims.

For New York State, there is a far better alternative to shale gas. A peer-reviewed study shows that it is feasible, with currently available technology, to transition New York State to 100% renewable energy in the form of wind, water and sunlight for all purposes by 2050 at the latest, and we can get to 85% by 2030 (the 2030 WWS plan). Transitioning to the 2030 WWS plan would create 4.5 million jobs during construction and approximately 58,000 permanent annual jobs thereafter for energy facilities alone developed as part of the plan. These numbers do not include the additional jobs “associated with the enhancement of the transmission system and with the conversion to electric and hydrogen fuel cell vehicles, electricity-based appliances for home heating and cooling, and electricity and hydrogen use for some heating and high-temperature industrial processes.” And these estimates do not include the jobs that will be created by retrofits to homes and buildings in order to increase energy efficiency and conservation. In fact, “the number of permanent jobs created by the electric power sector alone is expected to exceed significantly the number of lost jobs in current fossil-fuel industries [24]”

If instead of shale gas, New York State were to transition as quickly as possible to 100% renewable energy for all purposes, job creation will far exceed job creation from shale gas development without all the negative impacts of fossil fuels, and shale gas in particular, setting an example for the entire country.

Conclusions

Recent estimates of potentially recoverable shale gas in New York State and the resulting impacts on employment levels are far lower than DEC's estimates. Thus, there continues to be tremendous uncertainty surrounding shale gas development and all of its impacts on New York State.

The low levels of potential job creation coupled with the risks inherent in shale gas development make the case that shale gas development should not be allowed in New York State. The DEC is serving industry, not New York State, in continuing its reliance on the flawed analysis done by E&E in the Economic Assessment for the SGEIS.

It is unconscionable that a number of New Yorkers, individuals with expertise in related areas yet are either retired or working in full time jobs, have to spend days, weeks and even years of their lives working pro bono on the issue of shale gas development in New York State because the DEC prioritizes industry aims over protection of New Yorkers.

If the production and well development estimates provided by the NYS Potential Shale group are accurate, and if shale gas drilling is permitted in NYS, then it appears that excessive wells would be drilled and fracked without producing substantial amounts of natural gas. The risks of water, air and land contamination and related negative health impacts, as well as the radioactive drilling waste and other costs to communities, would be borne by New York State and its citizens. In return, the State would see very little in the form of gas production, job creation, earnings and tax revenue. The New York State economy would clearly suffer.

Polling results show that the negative impacts associated with fracking and shale gas development are increasingly being recognized by the population. In growing numbers, the people of New York are showing that they do not want New York fracked. Our elected officials should listen to the people, not to the gas industry.

Governor Cuomo has wisely initiated the New York Green Bank, but the 2014 draft New York State energy plan relies far too heavily on the use of natural gas, a dirty fossil fuel. The State must begin to phase out the production and use of all fossil fuels and immediately move along a path that leads to a full transition to renewable energy. New York State can transition to 100% renewable energy for all purposes, and the transition would have huge positive impacts on New York State's economy.

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