Ecological Economics and Rio + 20; A Presentation Given by Deborah Rogers in Rio de Janeiro, June 2012

Shale Gas or Shell Game?
By Deborah Rogers

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There is no doubt that gas exists in shale. That is a given. But shale gas has been touted as a cheap and abundant source of energy. Much emphasis has focused purely on the amount of gas trapped in shales but much of this gas may never be commercially extractable unless natural gas prices rise dramatically. In that case, natural gas is no longer a cheap source of energy.

It is important to sift through all the hype and rhetoric to assess whether production can truly be counted on to provide benefits. For instance, has production been as secure as it appears? Have jobs and revenues really been as stable as claimed? What have the environmental impacts really been? Can we count on energy independence from shale gas and unconventional oil?

In August, 2011, the U.S. Geological Survey (USGS) slashed reserve estimates for the Marcellus by 80%. (1) The Energy Information Administration (EIA) followed suit in January, 2012 by slashing its reserves estimates for the Marcellus by 66% and overall U.S. reserves of natural gas by 40%. (2) Prior erroneous estimates had been provided to government by industry. Interestingly, the same scenario played out in Poland and reserves there have recently been slashed by 85%. (3) Again, prior erroneous estimates had been provided by industry. And lastly we learn that shale reserves have now been slashed in India quite considerably as well. (4)

A leading argument states that shale gas "[has risen] from 2 percent of all natural gas production in 2000 [in the U.S.] to 23 percent 10 years later," a statistic the M.I.T. group called a "paradigm shift." (5) But this is misleading unless put into context. Drilling for conventional gas (i.e. vertical drilling) began to wane in the U.S. in the 1970′s. When shale gas (i.e. horizontal drilling) began to be drilled in earnest, Wall Street invested billions. Consequently, investment in conventional gas projects was decimated in the U.S. Therefore, shale gas is merely replacing older conventional projects, not adding to them. EIA estimates that natural gas will only grow by .8% per annum through 2030.

Further complicating the picture is the fact that shale wells, by their very nature, can have high initial production which drops off significantly about 12-18 months out and never recovers to initial levels. High initial production, however, can give the impression that shale gas is more successful than it may really be.

Lee Raymond, the former CEO of ExxonMobil, recently questioned shale gas reserves. Mr. Raymond stated "…It's going to be a little while before people are really confident that there is going to be a sufficient amount of gas for 30 years…I'm frankly not sure that we have enough experience with shale

gas to make the kind of judgment…". (6)

So is this "shale gas revolution" truly a "boom"? It has certainly been characterized as a "boom", but it makes sense to delve deeper into the underlying fundamentals before jumping on board.

It is a fact that while gas prices were plummeting after the economic downturn, many shale companies continued to drill rather than shut in wells. Shutting in wells has always been the traditional approach to low prices for the oil and gas industry. Shale wells, however, deplete so quickly that new wells must be drilled continuously and prolifically to maintain cash flow and production. Given the heavy debt loads of some shale gas operators, continuous drilling was a way to meet debt service but in turn decimated prices. Further, it has become apparent that perpetual expansion through drilling cannot keep production stable regardless of the frenzied pace. Financial analysts and journalists refer to this as the "drilling treadmill."

An excellent example of the drilling treadmill can be seen by examining the audited accounts of the City of Fort Worth in the Barnett shale play. (7) In 2008, the city received approximately $50M in gas revenues. This dropped precipitously in 2009 to about $19M. In 2010, it trended back up and closed the year at approximately $38M. On the surface, it would seem that things were simply recovering from the economic downturn and returning to normal — until the number of producing wells is considered.

Between 2008 and 2010, the number of producing wells within the city proper grew more than fourfold. So even though there were now four times more wells, these new wells could only keep revenues at 2/3 the levels seen in 2008. Although gas prices did decline during this period, severe depletion rates of the older wells was clearly the primary contributor.

By the way, this pattern has occurred repeatedly in North Texas. For instance, Denton County saw a 58% increase in number of wells for a 23% decrease in revenues. The wells at DFW airport have come in with dismal returns. (8) They never performed up to original projections. Chesapeake Energy needed 2.0/Bcf to break even. The wells have produced .9/Bcf . The University of Texas at Arlington saw revenues peak at approximately $7M with a mere 6 wells on campus to plummet drastically in a matter of months. Revenues in 2010 were down to $800K even though there were now 22 wells on campus.

While wells were proliferating and revenues plummeting, however, gas drilling was providing copious pollution and environmental degradation. The city of Ft. Worth released the findings of a report in June 2011 conducted by Eastern Resources Group (ERG) on all the gas facilities in the city proper.(9) Benzene, a known human carcinogen, is being emitted at quantifiable levels at 94% of the sites within the city. Another toxic compound, formaldehyde, also a known carcinogen and precursor for ozone, was detected by Titan Engineering at extraordinarily high levels in an industry funded study although greatly downplayed by industry. (10) In addition, carbon disulfide and various other toxics have also been detected in numerous tests contributing to an overall toxic cocktail. The Texas Commission for Environmental Quality (TCEQ) concluded after their testing that "gas facilities can, and sometimes do emit compounds at levels that could be deemed unsafe". (11)

Further, TCEQ submitted a report to EPA in December 2011 which confirms that gas drilling operations in the Barnett are contributing significantly more volatile organic compounds (VOCs) than all cars, trucks and other on-road mobile sources combined in the area. (12) Mobile sources account for 80 tons per day (tpd) of VOCs while gas drilling is estimated to account for 114 tpd. That is 42% higher than mobile sources. Further, VOCs from gas drilling have grown 60% in a mere 6 years correlating with the most significant growth in drilling for the region. VOCs are also known causes of ozone and Dallas-Ft. Worth has now passed Houston (2011) as having violated federal ozone standards the most of any area in Texas. (13)

Perhaps most problematic, however, is the fact that VOCs are known causes of debilitating diseases such as childhood asthma of which the children of Tarrant County (home to Ft.Worth Tx. and the heart of the Barnett Shale) suffer at the astonishing rate of 25% or three times the state average and about 2.5 times the national average.(14)

Such pollution is not unique to Texas. A research team at Cornell University issued a paper in late 2010 which estimated emissions from shale formations and concluded that, taken the full life cycle including drilling , completion and production, shale gas was not cleaner than coal. (15) In fact, it is almost twice as dirty. Industry pushed back hard against the study claiming it was exaggerating emissions on a vast scale. Interestingly, the University of Colorado at Boulder together with the National Oceanic and Atmospheric Administration recently released the results of a three year study of natural gas fields north of Denver Colorado. (16) Methane emissions were found to be twice as high as emission inventories and corroborated the Cornell research teams conclusions. In fact, actual field measurements turned out to be greater than the Cornell scientist's original projections.

Further, job growth has not been as great as industry and political claims. According to the Bureau of Labor Statistics, a low point for total employment in the oil and gas extraction sector occurred in 2003 with approximately 118,000 jobs. Between 2003 and 2011, job growth did grow 56% to reach 186,000 jobs, a net gain of 67,900 jobs but this occurred over nearly a decade. To put this into perspective, this job creation amounted to 1/20th of 1% of overall employment figures in the U.S. There are currently 12.8 million unemployed. A growth of 67,900 jobs in the entire oil and gas sector, onshore and offshore, during a period of "game changing", "revolutionary" activity in the natural gas markets demonstrates beyond a shadow of a doubt that jobs creation is overhyped to an unconscionable degree.(17)

Shale gas also presents problems from a land use perspective. Dr. John Lee, a petroleum engineer and the architect of the U.S. Securities and Exchange Commission (SEC) rule change for oil and gas stated "It is sometimes said that 20% of shale wells carry a project…the other 80% can easily be uneconomic."(18)

Because of the way fracture stimulation works, shale gas is extraordinarily land consumptive. Vast tracts of land are pockmarked with a grid pattern of pad sites approximately every 2500 feet, north, south, east and west in more mature plays. Further, to date there are no complete reclamation plans that have been mandated for natural gas pad sites. Once wells have played out, usually within ten years, the land is virtually worthless because without reclamation it cannot be used for any other purpose and

equipment is often left to rust on site. 80% of land used for shale production will be uneconomic at best. In the Barnett, 94% of the land has proven uneconomic.

And yet another problem has emerged regarding land use and shale gas. Though production cuts were announced by a number of shale gas companies in January 2012 due to the destabilization of the market and severe price declines, these cuts have not materialized in any meaningful way. In fact, many of these production cuts appear to be little more than housecleaning of embarrassing assets. For instance, according to some company press releases, wells that have been drilled will not be completed and other wells which have been completed will not be hooked up to pipelines. (19) This is in effect an abandonment and as such the land will produce no revenues of any kind in the form of taxes or royalties and yet cannot be used for any other purpose due to the lack of a reclamation plan. It is now virtually worthless.

According to production history filed by operators in various states, shale gas volumes have not turned out to be as homogeneous as once thought. In the earlier days of the plays, it was widely touted that you could drop a bit and hit gas anywhere in one of these plays. Aubrey McClendon, CEO of Chesapeake Energy, admitted to Bloomberg that "There was a time you all were told that any of the 17 counties in the Barnett Shale play would be just as good as any other county. We found out there are about two or two and a half counties where you really want to be." It is now known that every shale play in the U.S. has been reduced to such a core or tier area.

Yet even within those core areas, production can be erratic. Geologists at Labyrinth Consulting have examined 9,100 of the 15,000 wells in the Barnett play using production data filed by the operators with the Texas Railroad Commission and found that less than 6% actually met minimum economic thresholds. (20)

This is not unique to the Barnett either. According to the Powers Energy investor, Chesapeake and Southwestern had claimed average EUR's in the Fayetteville of as much as 2.4-2.6 Bcf. But there has never been a single shale well in the Fayetteville play that has ever produced more than 1.7 Bcf according to production data filed with the Arkansas Oil and Gas Commission. Most do well to produce even 1 Bcf and the average for Chesapeake wells is 541 Mcf. (21)

In the Haynesville play, operators claim EURs between 5-7.5 Bcf. Actual EURs based on historical production are PetroHawk 4.5, Encana 3.5, EOG 3.0 and CHK 2.75. Clearly substantial overestimation of reserves has occurred in each play. (20)

Under the new SEC rule for oil and gas adopted in 2009, companies can now claim reserves that were previously not allowed and book them without a mandatory third party audit. There is a clear upside to being able to book more reserves. It is the ability to make it appear that growth is occurring in a company and finding costs are plummeting. Some shale gas companies actually increased reserves by as much as 200% on their books after the rule change. Yet without independent third party audits there is no certain way to assess whether these reserves truly exist in a viable way. Perhaps even more problematic is that fact that these companies were allowed to borrow monies based upon such claims of

assets. Further anomalies have arisen in the SEC filings. SEC has informed some companies that they are calculating reserves at "mathematically impossible rates."

In the first two weeks of January 2012, near record prices were paid by foreign entities, primarily foreign Majors, for U.S. shale assets. Eight billion dollars ($8B) in deals was consummated. This would seem paradoxical given the inherent economic problems with shale gas until one considers the pricing imparities between crude and natural gas and the rising spectre of U.S. shale gas exportation and the SEC rule change.

Each publicly traded oil and gas company has two sets of economics: the first is the field economics, which is the actual well performance data and actual costs; and the second is the "Street" economics, which is what drives the share price. The better internal numbers look on financial statements such as reserve estimates, costs etc., the more monies that are available in the capital markets. In addition, investors like to see a growth trajectory for a company. A company that cannot show future growth is almost certainly going to languish at some point.

It is interesting to note that the Majors, without exception, have not been able to grow reserves in over a decade. It is also interesting to note how they have dealt with this fact. They chose to invest enormous sums of money in share repurchase programs. This is an effective way to keep a company looking as though it is growing when in fact it is not. Buying back shares reduces the number of shares outstanding and therefore increases earnings per share.

Exxon Mobil Corp., Chevron Corp., Royal Dutch Shell, BP and ConocoPhillips have poured billions in recent years into share repurchase programs, which has increased the value of their stocks. ExxonMobil, for instance, spent $11.2 billion on share repurchases in 2010. (22) This increased in 2011 with the company repurchasing as much as $5B a quarter.

Due to the changes in the SEC rule for Oil and Gas, these companies can now claim shale assets that have not necessarily been independently verified and it can appear that growth in reserves is once again occurring in the Major's portfolios.

But there is another aspect to this which is potentially much greater than the appearance of growth to these companies. It is the fact that crude oil hit record highs in 2011 in the international markets.

The price of natural gas in Asia and Europe is indexed to the price of crude oil. In fact, while gas trades in the US currently around $2.00/mcf in the U.S., it is trading at approximately $12-16/mcf in Asia depending on the length of the contract. Operators could theoretically extract, pipe, refine and ship to Asia from the U.S. for about $9. It can then be sold for as much as $16. That is eight times what the domestic U.S. market pays and a very profitable spread.

To sum up, although touted as the "bridge fuel", shale gas may not be the best choice after all. Clearly there are inherent difficulties with extraction including air toxics, possible ground water ruination, water depletion, land consumption and subsequent degradation, methane emissions more potent than

carbon dioxide and health impacts to surrounding communities. Further, the economics are questionable at best. Platts Oil and Gas Reporter, a preeminent industry publication, stated in December 2010 that "the switch from [shale] gas to [shale] oil suggests shale gas can survive only through cross-subsidization, not on its own merit. Perpetual expansion cannot forever disguise a serious problem with the bottom line." (23)

But perpetual expansion is what shale gas does best. It is the very nature of the beast.

Wells have declined so rapidly in every shale play to date that perpetual expansion has been the only option open for operators to keep production levels up. But serious consideration must be given before turning landscapes worldwide into industrial, desertified regions all for the sake of a "bridge fuel". Land consumption, when it is known beforehand that 80% of the wells will be uneconomic, becomes of paramount importance. Shale gas wells have proved short lived in the U.S. thus far. Without a comprehensive reclamation plan in place, the land then becomes worthless for other purposes and cannot generate revenues.

We have all witnessed flood after flood, earthquake after earthquake, freak storms and unseasonable weather patterns throughout the globe. The human costs of such devastation have greeted us on the evening news no matter where we reside. But make no mistake, there will be a tipping point where the human costs are finally and truly measured in dollars and rupees and reals. When this occurs, the excuse and platitudes of job growth of a mere 67,900 over a decade will pale into insignificance and economic stability will be a joke.

Clearly there are extensive questions surrounding claims by the oil and gas industry regarding shale gas production and its abundance and surety. As we have seen, reserves have been vastly overstated in every major shale play in the U.S., reserve estimates are being slashed worldwide, revenues have not proved long lived or reliable, jobs have not proved long lived or as numerous as industry claims, land has been degraded by drilling and then abandoned, wells haven proven short lived, and industry insiders readily admit that 80% of shale wells can "easily be uneconomic."

I will conclude with a comment that I truly wish I could take credit for because it is so brilliant…but I can't. It belongs to Warren Buffet. He made this comment after the economic meltdown in 2008 but I find it very apropos now with regard to shale gas and particularly concerning the demise of Chesapeake Energy, the second largest natural gas producer in the U.S. And the comment is this: when the tide goes out, that's when you get to see who has been swimming naked all along."

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Under the new SEC rule for oil and gas adopted in 2009, companies can now claim reserves that were previously not allowed and book them without a mandatory third party audit. There is a clear upside to being able to book more reserves. It is the ability to make it appear that growth is occurring in a company and finding costs are plummeting. Some shale gas companies actually increased reserves by as much as 200% on their books after the rule change. Yet without independent third party audits there is no certain way to assess whether these reserves truly exist in a viable way. Perhaps even more problematic is that fact that these companies were allowed to borrow monies based upon such claims of

assets. Further anomalies have arisen in the SEC filings. SEC has informed some companies that they are calculating reserves at "mathematically impossible rates."

In the first two weeks of January 2012, near record prices were paid by foreign entities, primarily foreign Majors, for U.S. shale assets. Eight billion dollars ($8B) in deals was consummated. This would seem paradoxical given the inherent economic problems with shale gas until one considers the pricing imparities between crude and natural gas and the rising spectre of U.S. shale gas exportation and the SEC rule change.

Each publicly traded oil and gas company has two sets of economics: the first is the field economics, which is the actual well performance data and actual costs; and the second is the "Street" economics, which is what drives the share price. The better internal numbers look on financial statements such as reserve estimates, costs etc., the more monies that are available in the capital markets. In addition, investors like to see a growth trajectory for a company. A company that cannot show future growth is almost certainly going to languish at some point.

It is interesting to note that the Majors, without exception, have not been able to grow reserves in over a decade. It is also interesting to note how they have dealt with this fact. They chose to invest enormous sums of money in share repurchase programs. This is an effective way to keep a company looking as though it is growing when in fact it is not. Buying back shares reduces the number of shares outstanding and therefore increases earnings per share.

Exxon Mobil Corp., Chevron Corp., Royal Dutch Shell, BP and ConocoPhillips have poured billions in recent years into share repurchase programs, which has increased the value of their stocks. ExxonMobil, for instance, spent $11.2 billion on share repurchases in 2010. (22) This increased in 2011 with the company repurchasing as much as $5B a quarter.

Due to the changes in the SEC rule for Oil and Gas, these companies can now claim shale assets that have not necessarily been independently verified and it can appear that growth in reserves is once again occurring in the Major's portfolios.

But there is another aspect to this which is potentially much greater than the appearance of growth to these companies. It is the fact that crude oil hit record highs in 2011 in the international markets.

The price of natural gas in Asia and Europe is indexed to the price of crude oil. In fact, while gas trades in the US currently around $2.00/mcf in the U.S., it is trading at approximately $12-16/mcf in Asia depending on the length of the contract. Operators could theoretically extract, pipe, refine and ship to Asia from the U.S. for about $9. It can then be sold for as much as $16. That is eight times what the domestic U.S. market pays and a very profitable spread.

To sum up, although touted as the "bridge fuel", shale gas may not be the best choice after all. Clearly there are inherent difficulties with extraction including air toxics, possible ground water ruination, water depletion, land consumption and subsequent degradation, methane emissions more potent than

carbon dioxide and health impacts to surrounding communities. Further, the economics are questionable at best. Platts Oil and Gas Reporter, a preeminent industry publication, stated in December 2010 that "the switch from [shale] gas to [shale] oil suggests shale gas can survive only through cross-subsidization, not on its own merit. Perpetual expansion cannot forever disguise a serious problem with the bottom line." (23)

But perpetual expansion is what shale gas does best. It is the very nature of the beast.

Wells have declined so rapidly in every shale play to date that perpetual expansion has been the only option open for operators to keep production levels up. But serious consideration must be given before turning landscapes worldwide into industrial, desertified regions all for the sake of a "bridge fuel". Land consumption, when it is known beforehand that 80% of the wells will be uneconomic, becomes of paramount importance. Shale gas wells have proved short lived in the U.S. thus far. Without a comprehensive reclamation plan in place, the land then becomes worthless for other purposes and cannot generate revenues.

We have all witnessed flood after flood, earthquake after earthquake, freak storms and unseasonable weather patterns throughout the globe. The human costs of such devastation have greeted us on the evening news no matter where we reside. But make no mistake, there will be a tipping point where the human costs are finally and truly measured in dollars and rupees and reals. When this occurs, the excuse and platitudes of job growth of a mere 67,900 over a decade will pale into insignificance and economic stability will be a joke.

Clearly there are extensive questions surrounding claims by the oil and gas industry regarding shale gas production and its abundance and surety. As we have seen, reserves have been vastly overstated in every major shale play in the U.S., reserve estimates are being slashed worldwide, revenues have not proved long lived or reliable, jobs have not proved long lived or as numerous as industry claims, land has been degraded by drilling and then abandoned, wells haven proven short lived, and industry insiders readily admit that 80% of shale wells can "easily be uneconomic."

I will conclude with a comment that I truly wish I could take credit for because it is so brilliant…but I can't. It belongs to Warren Buffet. He made this comment after the economic meltdown in 2008 but I find it very apropos now with regard to shale gas and particularly concerning the demise of Chesapeake Energy, the second largest natural gas producer in the U.S. And the comment is this: when the tide goes out, that's when you get to see who has been swimming naked all along."

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Ecological Economics and Rio + 20; A Presentation Given by Deborah Rogers in Rio de Janeiro, June 2012

Shale Gas or Shell Game?
By Deborah Rogers

Presented at the International Society of Ecological Economics (ISEE) Conference in conjunction with the United Nations Rio + 20, Rio de Janeiro, June 2012

There is no doubt that gas exists in shale. That is a given. But shale gas has been touted as a cheap and abundant source of energy. Much emphasis has focused purely on the amount of gas trapped in shales but much of this gas may never be commercially extractable unless natural gas prices rise dramatically. In that case, natural gas is no longer a cheap source of energy.

It is important to sift through all the hype and rhetoric to assess whether production can truly be counted on to provide benefits. For instance, has production been as secure as it appears? Have jobs and revenues really been as stable as claimed? What have the environmental impacts really been? Can we count on energy independence from shale gas and unconventional oil?

In August, 2011, the U.S. Geological Survey (USGS) slashed reserve estimates for the Marcellus by 80%. (1) The Energy Information Administration (EIA) followed suit in January, 2012 by slashing its reserves estimates for the Marcellus by 66% and overall U.S. reserves of natural gas by 40%. (2) Prior erroneous estimates had been provided to government by industry. Interestingly, the same scenario played out in Poland and reserves there have recently been slashed by 85%. (3) Again, prior erroneous estimates had been provided by industry. And lastly we learn that shale reserves have now been slashed in India quite considerably as well. (4)

A leading argument states that shale gas "[has risen] from 2 percent of all natural gas production in 2000 [in the U.S.] to 23 percent 10 years later," a statistic the M.I.T. group called a "paradigm shift." (5) But this is misleading unless put into context. Drilling for conventional gas (i.e. vertical drilling) began to wane in the U.S. in the 1970′s. When shale gas (i.e. horizontal drilling) began to be drilled in earnest, Wall Street invested billions. Consequently, investment in conventional gas projects was decimated in the U.S. Therefore, shale gas is merely replacing older conventional projects, not adding to them. EIA estimates that natural gas will only grow by .8% per annum through 2030.

Further complicating the picture is the fact that shale wells, by their very nature, can have high initial production which drops off significantly about 12-18 months out and never recovers to initial levels. High initial production, however, can give the impression that shale gas is more successful than it may really be.

Lee Raymond, the former CEO of ExxonMobil, recently questioned shale gas reserves. Mr. Raymond stated "…It's going to be a little while before people are really confident that there is going to be a sufficient amount of gas for 30 years…I'm frankly not sure that we have enough experience with shale

gas to make the kind of judgment…". (6)

So is this "shale gas revolution" truly a "boom"? It has certainly been characterized as a "boom", but it makes sense to delve deeper into the underlying fundamentals before jumping on board.

It is a fact that while gas prices were plummeting after the economic downturn, many shale companies continued to drill rather than shut in wells. Shutting in wells has always been the traditional approach to low prices for the oil and gas industry. Shale wells, however, deplete so quickly that new wells must be drilled continuously and prolifically to maintain cash flow and production. Given the heavy debt loads of some shale gas operators, continuous drilling was a way to meet debt service but in turn decimated prices. Further, it has become apparent that perpetual expansion through drilling cannot keep production stable regardless of the frenzied pace. Financial analysts and journalists refer to this as the "drilling treadmill."

An excellent example of the drilling treadmill can be seen by examining the audited accounts of the City of Fort Worth in the Barnett shale play. (7) In 2008, the city received approximately $50M in gas revenues. This dropped precipitously in 2009 to about $19M. In 2010, it trended back up and closed the year at approximately $38M. On the surface, it would seem that things were simply recovering from the economic downturn and returning to normal — until the number of producing wells is considered.

Between 2008 and 2010, the number of producing wells within the city proper grew more than fourfold. So even though there were now four times more wells, these new wells could only keep revenues at 2/3 the levels seen in 2008. Although gas prices did decline during this period, severe depletion rates of the older wells was clearly the primary contributor.

By the way, this pattern has occurred repeatedly in North Texas. For instance, Denton County saw a 58% increase in number of wells for a 23% decrease in revenues. The wells at DFW airport have come in with dismal returns. (8) They never performed up to original projections. Chesapeake Energy needed 2.0/Bcf to break even. The wells have produced .9/Bcf . The University of Texas at Arlington saw revenues peak at approximately $7M with a mere 6 wells on campus to plummet drastically in a matter of months. Revenues in 2010 were down to $800K even though there were now 22 wells on campus.

While wells were proliferating and revenues plummeting, however, gas drilling was providing copious pollution and environmental degradation. The city of Ft. Worth released the findings of a report in June 2011 conducted by Eastern Resources Group (ERG) on all the gas facilities in the city proper.(9) Benzene, a known human carcinogen, is being emitted at quantifiable levels at 94% of the sites within the city. Another toxic compound, formaldehyde, also a known carcinogen and precursor for ozone, was detected by Titan Engineering at extraordinarily high levels in an industry funded study although greatly downplayed by industry. (10) In addition, carbon disulfide and various other toxics have also been detected in numerous tests contributing to an overall toxic cocktail. The Texas Commission for Environmental Quality (TCEQ) concluded after their testing that "gas facilities can, and sometimes do emit compounds at levels that could be deemed unsafe". (11)

Further, TCEQ submitted a report to EPA in December 2011 which confirms that gas drilling operations in the Barnett are contributing significantly more volatile organic compounds (VOCs) than all cars, trucks and other on-road mobile sources combined in the area. (12) Mobile sources account for 80 tons per day (tpd) of VOCs while gas drilling is estimated to account for 114 tpd. That is 42% higher than mobile sources. Further, VOCs from gas drilling have grown 60% in a mere 6 years correlating with the most significant growth in drilling for the region. VOCs are also known causes of ozone and Dallas-Ft. Worth has now passed Houston (2011) as having violated federal ozone standards the most of any area in Texas. (13)

Perhaps most problematic, however, is the fact that VOCs are known causes of debilitating diseases such as childhood asthma of which the children of Tarrant County (home to Ft.Worth Tx. and the heart of the Barnett Shale) suffer at the astonishing rate of 25% or three times the state average and about 2.5 times the national average.(14)

Such pollution is not unique to Texas. A research team at Cornell University issued a paper in late 2010 which estimated emissions from shale formations and concluded that, taken the full life cycle including drilling , completion and production, shale gas was not cleaner than coal. (15) In fact, it is almost twice as dirty. Industry pushed back hard against the study claiming it was exaggerating emissions on a vast scale. Interestingly, the University of Colorado at Boulder together with the National Oceanic and Atmospheric Administration recently released the results of a three year study of natural gas fields north of Denver Colorado. (16) Methane emissions were found to be twice as high as emission inventories and corroborated the Cornell research teams conclusions. In fact, actual field measurements turned out to be greater than the Cornell scientist's original projections.

Further, job growth has not been as great as industry and political claims. According to the Bureau of Labor Statistics, a low point for total employment in the oil and gas extraction sector occurred in 2003 with approximately 118,000 jobs. Between 2003 and 2011, job growth did grow 56% to reach 186,000 jobs, a net gain of 67,900 jobs but this occurred over nearly a decade. To put this into perspective, this job creation amounted to 1/20th of 1% of overall employment figures in the U.S. There are currently 12.8 million unemployed. A growth of 67,900 jobs in the entire oil and gas sector, onshore and offshore, during a period of "game changing", "revolutionary" activity in the natural gas markets demonstrates beyond a shadow of a doubt that jobs creation is overhyped to an unconscionable degree.(17)

Shale gas also presents problems from a land use perspective. Dr. John Lee, a petroleum engineer and the architect of the U.S. Securities and Exchange Commission (SEC) rule change for oil and gas stated "It is sometimes said that 20% of shale wells carry a project…the other 80% can easily be uneconomic."(18)

Because of the way fracture stimulation works, shale gas is extraordinarily land consumptive. Vast tracts of land are pockmarked with a grid pattern of pad sites approximately every 2500 feet, north, south, east and west in more mature plays. Further, to date there are no complete reclamation plans that have been mandated for natural gas pad sites. Once wells have played out, usually within ten years, the land is virtually worthless because without reclamation it cannot be used for any other purpose and

equipment is often left to rust on site. 80% of land used for shale production will be uneconomic at best. In the Barnett, 94% of the land has proven uneconomic.

And yet another problem has emerged regarding land use and shale gas. Though production cuts were announced by a number of shale gas companies in January 2012 due to the destabilization of the market and severe price declines, these cuts have not materialized in any meaningful way. In fact, many of these production cuts appear to be little more than housecleaning of embarrassing assets. For instance, according to some company press releases, wells that have been drilled will not be completed and other wells which have been completed will not be hooked up to pipelines. (19) This is in effect an abandonment and as such the land will produce no revenues of any kind in the form of taxes or royalties and yet cannot be used for any other purpose due to the lack of a reclamation plan. It is now virtually worthless.

According to production history filed by operators in various states, shale gas volumes have not turned out to be as homogeneous as once thought. In the earlier days of the plays, it was widely touted that you could drop a bit and hit gas anywhere in one of these plays. Aubrey McClendon, CEO of Chesapeake Energy, admitted to Bloomberg that "There was a time you all were told that any of the 17 counties in the Barnett Shale play would be just as good as any other county. We found out there are about two or two and a half counties where you really want to be." It is now known that every shale play in the U.S. has been reduced to such a core or tier area.

Yet even within those core areas, production can be erratic. Geologists at Labyrinth Consulting have examined 9,100 of the 15,000 wells in the Barnett play using production data filed by the operators with the Texas Railroad Commission and found that less than 6% actually met minimum economic thresholds. (20)

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