NPG Negative Population Growth, Inc.

IS FRACKING AN ANSWER? TO WHAT?

An NPG Forum Paper

By Lindsey Grant

Hydraulic fracturing ("fracking" in the popular literature; "fracing" in some technical journals) is a technique for expanding gas and oil production. It is dramatically raising expectations for future gas and oil production, and technological optimists are hailing it as the answer to fears of a decline in world fossil energy production. In fact, it is still largely an unknown, and we cannot say with any confidence how it will affect the future of fossil energy. If indeed it does contribute substantially to world energy supplies – particularly gas – there will be profound ramifications, and they are not all benign. If it is simply used to support more growth, the new supply will support an unsupportable life style for a little longer and then lead to a deeper collapse. If we recognize the limits to growth, perhaps we can use it to ameliorate the transition. I shall describe the process briefly, identify some of its strengths and dangers, and offer a tentative evaluation of its potential impacts on world issues from climate change to food and the future of human populations.

The Process. Fracking is a hot topic right now. It is treated as something new on Earth. In fact, two technologies – fracking and horizontal drilling – have matured at the same time. Both have been around for some time, fracking experiments since the 19th Century and horizontal drilling for decades. What has changed is that directional drilling and downhole pumps have dramatically improved. They, and the rising price of oil and gas, made it worthwhile to explore formations that had not heretofore been economically interesting, and fracking has provided a way to loosen the "tight" shale formations that were known to contain gas and oil, but had resisted exploitation. Oil exploration had been confined to more workable sandstones and limestones, and most gas production was associated with oil or extracted from other formations, but very little of it from shale. There is a lot of shale in the world, and some of it is rich in gas and oil, but they were inaccessible unless they migrated into more exploitable formations. Suddenly, the shale itself became the target of exploitation.[1]

Horizontal drilling is self-explanatory, though how they can do it is a mystery to me. Assume you have an oil-bearing stratum two miles long but only 20 feet deep. It would be economically impossible to exploit the oil by drilling innumerable vertical wells through that 20 feet. Drill horizontally, and you may be able to collect from the whole two miles with one well. Since most of this activity occurs at depths from one to four miles, the saving is considerable.

Fracking is the process of opening fissures in tight rock by injecting water at very high pressure. The water is thickened with chemicals so that it can carry "proppants" (a lovely word!), consisting of sand or ceramic fragments. They lodge deep in the fissures and prop them open for the gas or oil to enter when the water is withdrawn.

Voila! You now have a way to access the shale and to loosen it up to release its hydrocarbons. Horizontal drilling and fracking are so effective that most new wells, even in conventional sandstones and limestones, now exploit them.

Early Successes. After Mitchell Energy showed that the technique worked in the Barnett shale in Texas, the industry has rushed in. U.S. shale gas production was negligible in 2000, when it took off. It has grown 48% per year from 2006 to 2010. It now provides 23% of current U.S. gas production.[2]

The result has been a gas boom – and glut. The winter price of gas futures is a key indicator, because gas is so widely used in heating. It has dropped from $11.92 per million BTU in 2005-2006 to the present $3.86, the lowest price in a decade. Growth enthusiasts are proclaiming that fears of a fossil energy crisis were a myth. A closer look suggests a different current scenario. Shale gas is replacing traditional sources more than it is driving production up. Total U.S. gas production rose less than 5% from 2008-2010.[3]

Shale oil production is much less advanced than shale gas. Most current activity is taking place in the Bakken formation in the Williston basin in North Dakota. The state's oil production has soared from negligible in 2002 to 445,000 barrels per day (b/d) in August 2011, most of it from Bakken shale. That is over 8% of total U.S. crude oil output. North Dakota has now become the fourth largest oil producing state, after Texas, Alaska and California, and has helped to arrest the decline in U.S. production, at least for the time being.[4] It is booming, unlike most of the country. (Montana and Saskatchewan share the basin but have done less to exploit it.) Unlike the impact of shale gas on gas prices, this activity has not visibly affected oil prices, because, unlike gas, oil is traded on a world market, the role of fracking is much smaller, and the price of oil depends on multiple factors.

Shale gas and oil production elsewhere in the world lag behind the U.S., but other countries are joining the parade. Foreign producers are buying into U.S. gas drillers to learn the technique. Poland has proclaimed an ambitious target of freeing Europe from its dependence on gas from Russia and Central Asia by 2035.[5] A Spanish company drilling in Argentina claims, perhaps hyperbolically, to have found exploitable shale gas resources comparable to the U.S. China is actively pursuing potential fields at home and abroad, as part of its ambitious program to secure energy and raw materials. Drilling was under way in France and the U.K. until interrupted by moratoria (see below.) Most world shale deposits are probably being looked at by the industry.

In short, shale gas has shaken up the industry and raised optimism about future growth and faith in the conventional wisdom that technology will always save us. Shale oil is off to a slower start, but it stirs similar hopes of energy independence – a wildly optimistic claim, as I will show later.

That much is known. Trying to predict future production and reserves is another matter, which I will return to later.

The Immediate Problems. The success of fracking has already generated problems and met resistance. Over the long term, it will generate much vaster problems if it significantly extends the fossil fuel era – which it probably will.

The immediate problems tend to be local.

Fracking uses something like five million gallons of water per well, in an era of growing water scarcities.

Some of the water is re-used, but the chemicals in the fracking fluids can cause water pollution. There are many anecdotal reports of contamination, some of them well documented. The EPA has just confirmed, for the first time, that fracking has been responsible for specific groundwater pollution (in Pavillion, WY) though it claimed that the pollution of residential water supplies was "generally" within acceptable limits.[6]

Like conventional wells, the shale wells release methane, which is dangerously combustible, but the new techniques may be more likely to release methane. There are weird reports of methane in the water from faucets in nearby houses catching fire. Fracking has brought such problems to new areas. And methane is a potent source of climate warming if it escapes into the atmosphere.

Minor earthquakes near Fort Worth were widely attributed to fracking in the Barnett shale, and a U.K. firm has acknowledged that "it is highly probable" that tremors near Blackpool, England, were triggered by its fracking activities, which led to a temporary injunction against fracking in the U.K.[7] All the earthquakes so far have been very small tremors, but one wonders what calamity might be set loose in a place such as Indonesia, which is in a major earthquake zone and is already a major producer of hydrocarbons, or the Monterey basin in California, close to the San Andreas fault, which is the most promising potential source of shale oil in the U.S. (see below).

The industry vigorously denies that fracking causes more local damage, air pollution, and greenhouse gas emissions than conventional drilling, but that claim is dubious. The huge holding ponds used to store the used fracking fluid alone add a new dimension to the pollution problems. (The exact chemical makeup of the fluid is secret proprietary information, by the way.) Over its life cycle, shale gas may or may not be cleaner than coal or tar sands such as those in Alberta, but that is a theoretical question, since we may anticipate that all exploitable fossil fuels will be used eventually, and thereby contribute their load to climate warming and the environment.

The activity has led to widespread uneasiness. The Council of Scientific Society Presidents in March 2010 warned of the need for much more thorough study of the possible consequences before giving approval to fracking proposals. The EPA on June 23rd announced a major study of the impact of fracking on groundwater pollution.

The uneasiness has led to moratoria or bans in many places, including at least France, Germany, the U.K., Australia, South Africa, Quebec, and several U.S. states.

Will this uneasiness stop or slow down the spread of the technique? It may, in some local situations, but history suggests that such objections are brushed aside when the smell of energy is in the air.

In one respect, the immediate consequences of fracking are already contributing to the larger long term issues. By pushing down the price of gas, the shale revolution is making solar and wind energy projects unviable. That in turn is pushing the development of post-carbon energy sources into a more distant future.

The Uncertain Future. The essential point is that we really don't know how the future of shale gas and oil will turn out. Bear with me as I present some mutually inconsistent official estimates below.

To take shale gas first: The U.S. Energy Information Administration (DOE/EIA) puts proven U.S. gas reserves at 265 tcf – a new high – 61 tcf of which is shale gas reserves. Total proven gas reserves are expected to rise a modest 19% by 2035.[8] EIA expects shale gas production to treble in that period, supplanting conventional sources, but admits to a "high degree of uncertainty". ("Proven reserves" are not a particularly valuable indicator of the total resource, because they are often not proven until the operators need to validate their presence for operational planning.)

"Unproven recoverable resources" of gas (beyond proven reserves) present a different problem. At this stage, they are hardly more than guesses. The official estimates from the U.S. Geological Survey (USGS) put the total mean undiscovered, recoverable U.S. gas resources at 1025 tcf, nearly twice the estimate made in 1950. Of that, 336 tcf consists of shale gas.[9] DOE/EIA cites a much higher figure of 750 tcf for shale gas resources, 86% of which are in the Northeast, with 55% in the Marcellus formation mostly in New York, Pennsylvania and perhaps West Virginia – a much higher estimate than USGS has made.[10] EIA is, however, notably cautious about those estimates, pointing out that exploration of the fields is just at the beginning, and much remains unknown about their extent or quality.

So far as I know, the only overall figure for world shale gas resources comes from The World Energy Council (WEC). It has patched together a questionably high estimate of world shale gas resources putting the recoverable resource at 6744 tcf.[11] WEC is obviously betting on shale gas. It puts world shale gas resources at 2.44 times "conventional gas", two-thirds of them in North America and the erstwhile Soviet Union area. It puts the recoverable North American shale gas resources at 1778 tcf. That includes Canada, but still it puts recoverable U.S. shale gas resources far higher than the USGS estimate.

Shale oil: We have no serious worldwide estimates. The national estimates of shale oil resources are much lower than the gas estimates. The USGS figure for all U.S. oil resources, including shale oil, is 35 billion barrels, which is less than half its 1950 estimate.[12] The DOE/EIA cites a mean estimate for recoverable shale oil in the U.S. of 24 billion barrels, only one-fifth of its figure for shale gas, in energy terms. Most of it is thought to be in the Monterey formation in California, with the Bakken field second. These estimates will change. The oil rigs are out in force, and we may expect a confusing series of new claims – probably hyperbolic – from drillers. As this paper is being written, the Texas driller Anadarko has claimed a discovery of "up to one billion barrels" of recoverable oil in Colorado. Maybe. The situation is, shall we say, fluid.

Speaking of energy independence, I would note that the EIA estimate above would replace just 2.6 years of U.S. crude oil imports, if it all proved out and all was pumped.

It has become fashionable to describe fracking as a "game changer" for fossil energy. Not necessarily. Fracking will add extra innings to the game, but the resource is finite, even with a high success rate. We will come to the end of the fossil energy era, but somewhat later than had been anticipated. That delay will, however, reverberate around the world.

Estimates of the date of peak world gas production have always been uncertain and mutually inconsistent, because of the multiplicity of gas sources and the difficulty of predicting how much is recoverable. The U.S. experience suggests, however, that gas shale will move the peak back some years or decades and substantially increase the ultimate recovery. It will replace oil and probably coal in many uses.

As to shale oil: peak world crude oil production from conventional sources may have been reached in 2005, and subsequent production has been on a fluctuating plateau.[13] The advent of shale oil will extend that plateau by an unpredictable period and may lead to another peak. Bear in mind, however, that production from existing fields is declining something like 6.3% per year, worldwide. At that rate – just to stay even – new fields must be found to supply 73% of current production by 2030.[14] Shale oil production will have to grow dramatically just to fill that growing gap, and it takes time to find and develop new fields. This all suggests that the era of decline will still begin before then, despite the advent of shale oil.

Even so, shale oil will delay the effective end of the petroleum era and mean that more oil will ultimately be recovered and burned than we expected.

What Are the Consequences of "Success"? People who live for the moment will celebrate the prospect that we will be able to continue our present wasteful ways for a few more years and that the shift to a more sustainable way of living – which will be painful – will be deferred. That comes, however, at the price of faster climate warming and a more rapid and painful adjustment when the oil and gas run down.

Perhaps I should begin this section on one small but cheerful note: shales are widespread around the world. The monopoly power of OPEC over oil will probably erode. Beyond that, there won't be much good news.

Barring the collapse of expectations for shale gas and oil, the new technologies will affect all the most important issues we face.

The energy transition: The first impact is to put off the transition to a post-fossil energy world (see above). In so far as gas and oil are available at competitive prices, it will tend to hold back the development of alternative energy on which we will eventually have to depend. Renewable energy cannot compete with fossil energy at present or foreseeable prices. We have hardly begun the transition to renewables, and it will be further delayed by the advent of shale gas and oil.

Climate: Shale oil and gas will increase the introduction of carbon dioxide (CO_2) and methane into the atmosphere, and do it longer. Recent evidence has already raised the estimates of the rate at which climate warming is changing the weather. We are witnessing melting glaciers, more erratic stream flows, more intense storms, more torrents and fewer gentle rains, the loss of lowlands to the sea, desertification, droughts and hotter temperatures. These changes are already measurable, and they are reducing the Earth's ability to support us and other species. Those patterns will become more painful and less deniable as the process continues and as more forests are lost to climate change.[15]

Water: Fresh water shortages are caused both by rising demand and climate change, and fracking competes for that water. Prolonging the fossil energy era may momentarily benefit urban water users, particularly near the coasts, by holding down the cost of desalination, which is energy-intensive (and is already suffering from rising energy costs). That is small consolation in the face of climate warming, which is disrupting natural fresh water supplies. About 70% of the human use of fresh water is for irrigation. It takes about 1000 tons of water to raise a ton of corn. Desalination and water recycling in greenhouses are possible for specialty crops, but not for most agriculture.

Food supply and population: This is where it all comes together. The prospect of more fossil energy from shale cuts both ways. Fossil fuels are central to modern food yields, particularly because they are used to capture nitrogen and make nitrogen fertilizers. World and U.S. populations have grown to their present levels only because agriculture produced enough food to feed them. In other papers, I have offered rough calculations of the populations that can be supported if we have to revert to earlier ways of capturing nitrogen.[16] Here are the numbers: half or less of the present U.S. population; 25% to 40% of world population, varying by country. The exact numbers are not important. The important thing is that we will need to adjust population numbers to fit the reduced food production that we may expect in the coming era of diminishing fossil fuels, climate change and freshwater disruptions. Some progress has been made (though not in the United States) but not enough. (See p.6.)

And here is where we still have a choice. We can simply use the shale discoveries to support present consumption patterns and the consequent damage. That choice – which is the one we are now taking – will mean more people overloading an already overloaded and deteriorating system, when eventually fossil energy does wind down. Or we can use the prolongation of the fossil fuel window to give us more time to bring human populations into better alignment with resources.

Biodiversity and the interdependent Earth: That choice will be made against a broader backdrop that most people seldom think of. We live in an interdependent world, from microorganisms to the climate. We may later come to realize that the major consequence of the capitalist era and of fossil energy has been to dramatically accelerate the rate at which mankind has taken minerals from the deep lithosphere and injected them into the biosphere and atmosphere. This causes a fundamental reordering of life processes. Human intervention in Earth processes is not simply limited to the climate. It affects the entire biosphere of which we are a part. Fossil fuels are themselves among the offending minerals, and they are the tools that we use to put other minerals into the biosphere and the atmosphere. Exploiting the gas and oil shales will prolong that disruptive activity by an amount presently unpredictable.

Much of modern science is focused on the effort to understand those impacts. To me, it is astonishing that our economic and political elites ignore those issues. That can perhaps be understood by examining two different world views.

The War of the Paradigms. The prospect of more gas and oil from shale intensifies a fundamental division about the nature of economic growth.

There are two conflicting growth paradigms in modern societies today. The first is the capitalist paradigm: the faith in endless growth that came out of capitalism and the Industrial Revolution. The second and newer paradigm is the finite Earth paradigm: the recognition that growth cannot go on forever on a finite planet, and the dawning realization of the damage we are doing to ourselves and the systems that support us. It began as a surmise and is now buttressed by the evidence around us. It springs from a sense of community and a recognition of our shared fate, which is totally alien to the individualism that supports the capitalist paradigm.

Believers in the capitalist growth paradigm see the additional gas and oil supplies as a shot in the arm, a way to inject some additional resources into the system to keep it growing. That will be a disaster because it will encourage the world's "leaders" to continue to pursue growth as the way out of our mounting world problems, in the face of the evidence that growth is already intensifying those problems.

The perpetual growth paradigm is a philosophical impossibility on a finite Earth.

The finite Earth paradigm is, I think, irrefutable. It is documented daily by the discoveries of science and by the changes we are witnessing in resources and living systems. I have written about this conflict of world views before, and will return to it.[17] For the moment, however, the issue is which paradigm we choose.

The perpetual growth paradigm is still dominant among Establishments everywhere in the industrial world. It is reflected in their faith in renewed growth as a solution to our mounting problems. Every economic summit calls for growth. Our Secretary of the Treasury can hardly open his mouth without calling for it. I wonder whether people steeped in the illusions of perpetual growth and continually rising prosperity can cast off the illusions and face a return to a much leaner reality. The growth is disintegrating, but the illusions persist. Greed and self-interest make the perpetual growth paradigm appealing. It requires an awareness of the changes we are inflicting on the Earth to embrace the finite Earth paradigm, and a strong sense of community to act on it, and neither characteristic seems to mark modern political life.

This is the backdrop against which we must decide what to do about the advent of shale gas and oil. Shall we simply use it to prop up the system for a little longer? Or can we somehow use it to prepare for the next stage of history?

The Finite Earth Paradigm. Let us hope that nations worldwide will move toward acceptance of the finite Earth paradigm and will begin to adjust to its limits. That process is consciously or unconsciously underway in many societies, judging by their fertility levels. Some developing country leaders believe in that paradigm, but the governments of most industrial nations – including the United States – do not. If we come to realize the limits, more energy will provide more time to make the adjustments to the new and leaner world.

Such adjustments require specific, effective measures to bring human demands back into balance with the Earth's capacity to meet them. This would embrace a range of specific measures such as agricultural reforms and reversing the destruction of forests.

The most important technical correction would be for all nations, and certainly the big ones, to impose graduated and progressively stiffer taxes on carbon dioxide (CO_2) emissions. This would slow down the emissions. It would raise the cost of fossil fuels and thereby make them last longer for critical uses. And by raising the price of fossil energy, it would make more benign renewables competitive. Such a tax would be impartial, which would encourage producers and users to experiment to find the way to produce and use energy in ways that minimize carbon releases. Contrast that approach with the present clumsy one of allowing bureaucrats or politicians to select a process or a company and then subsidize it.

... and that leads to another advantage. Rather than costing taxpayers money, it would help to balance budgets. In the current worldwide financial crisis, that is a compelling argument for CO_2 taxes. The stick is cheaper than the carrot. It does, however, require a strong social consensus that it is presently conspicuously lacking.

The one solution that cuts across all the others is to address demand directly.

Demand is the product of **population X consumption**. Consumption will probably pretty much take care of itself, as eroding incomes face rising prices.

Population is another matter. Human fertility has been halved in the past five decades. That is a remarkable achievement, but the last mile is the hardest. The great benefit of additional fossil energy could be to provide some more time to turn world population growth around before food production plummets. More fossil energy will make the climate problem worse, but at least there would be a trade-off.

Even with the best of wills, the task will not be easy. Elsewhere, I have cited and critiqued the UN 2010 population projections.[18] I propose to examine their implications at greater length in a forthcoming FORUM. For the moment, let me simply point out that world population is still rising, driven largely by the 58 most fertile nations. It will probably continue to do so until hunger and turmoil bring their growth to a halt, which may well occur in this century. The industrialized countries will need effective policies to control immigration if they are to preserve their own societies. The intermediate fertility countries (including the U.S.) will be faced with a continuing need to reduce fertility as well as immigration. The poorest and most fertile nations will avoid disaster only with a remarkable set of changes, including effective policies to bring about much lower fertility. Shale gas and oil have only a limited role in that scene, but they can be of some help by postponing the collapse of the world's fossil fuel economy.

Back to Shale. Where does all this lead us? It takes us back to the basic conclusion: shale gas and oil will for an unknown period prolong a world driven in the wrong direction by growth. It will provide a temporary palliative but it will set the stage for a more desperate future. We can envisage policies that ameliorate the problem, if we are willing to shift to the finite Earth paradigm. That shift may happen as the seas rise, storms and droughts get worse, the price of food and basic necessities climbs, the turmoil that we see around us intensifies, and the perpetual growth paradigm becomes less and less believable. Even a deliberate reversal to embrace a wiser vision of the Earth faces a multitude of obstacles and a highly problematic prospect. In any event, the war is worth fighting. The stakes are too high to run from it. It is not an either/or proposition. Any success in moving governments toward a more rational view of the world will be a gain. And we don't have much choice.

Ω

NOTES

1. The terms "shale gas" and "shale oil" have come into general use to describe the production from shale. This causes some confusion with the earlier use of "oil shale" to describe the kerogen shales that led to a failed oil rush on the Colorado Plateau a generation ago. Kerogen is a precursor of oil that must be heated and processed to make it into true crude oil.
2. DOE/EIA "Review of Emerging Resources: U.S. Shale Gas & Shale Oil Plays", 7-8-2011. These estimates, while published by EIA, were prepared for it by INTEK, Inc. and do not carry the authority of official estimates.
3. Price data from DOE/EIA Annual Energy Outlook (AEO) 2011. Preliminary production data from DOE/EIA Annual Energy Review (AER) 2010. Table 6.2 "Natural Gas Production 1949-2010".
4. DOE/EIA chart "Bakken Shale Production 1985-2010. Williston Basin, ND & MT" and supplemental notes.
5. Oil & Gas Journal online, 11-7-11.
6. Wikipedia, "Hydraulic Fracturing", accessed 11-4-11. See The New York Times report "The Fracturing of Pennsylvania", 11-17-11, for a harrowing description of the experience. EPA, Denver, 12-8-11 News Release: "EPA Releases Draft Findings of Pavillion, Wyoming, Ground Water Investigation..."
7. Reuters, London, 11-2-11.
8. DOE/EIA Annual Energy Outlook 2011, table "Oil & Gas End-of-Year and Annual Reserve Additions, Reference Case." The projections exclude Alaska.
9. USGS, "National Assessment of Oil & Gas Reserves Update, August 2011", and "Mean Shale Gas Resources" (8-2011).
10. Intek study cited in Note 2. USGS "Assessment of Undiscovered Oil and Gas Resources of the... Marcellus Shale... 2011" (posted 8-23-11).
11. World Energy Council 2010, "Survey of Energy Resources: Focus on Shale Gas."
12. See Note 9. I cannot reconcile their figure for oil with a March 5, 2009 statement by USGS Energy Resources Program Coordinator Brenda Pierce to the House Subcommittee on Energy and Natural Resources, that there are 48 billion barrels of recoverable undiscovered resources onshore and 86 billion barrels offshore.
13. See my NPG FOOTNOTE "Peak Oil 2005", September 2010.
14. 6.3% is the median of the estimates given by a sampling of oil experts by the Wall Street Journal, 1-17-08. See my NPG FORUM "The Edge of the Abyss", February 2008, p. 2.
15. See, for instance the Intergovernmnental Panel on Climate Change (IPCC) November 2011 report. For a summary of the threats to forests, and the consequences, see Justin Gillis, "With Deaths of Forests, a Loss of Key Climate Protectors", New York Times, 10-1-2011.
16. See my NPG FORUM "The Edge of the Abyss", February 2008, pp. 8-9.
17. See Lindsey Grant, Juggernaut: Growth on a Finite Planet (Santa Ana: Seven Locks Press, 1996) Chapter 14 or Valedictory: The Age of Overshoot (Alexandria, Va., Negative Population Growth, 2007), "The Economists' Myths", pp.38-44.
18. NPG FORUM, "The UN 2010 Population Projections: A Proposal", June 2011.

About the author: Lindsey Grant is a writer and former Deputy Assistant Secretary of State for Environment and Population. His books include: *VALEDICTORY: The Age Of Overshoot, The Collapsing Bubble: Growth and Fossil Energy, The Case for Fewer People: The NPG Forum Papers (editor), Too Many People: The Case for Reversing Growth, Juggernaut: Growth on a Finite Planet, How Many Americans?, Elephants in the Volkswagen,* and *Foresight and National Decisions: the Horseman and the Bureaucrat.*

This Forum, as well as other NPG publications, can be found on our internet website at **www.npg.org**.

NPG is a national membership organization founded in 1972. Annual dues are $30 and are tax-deductible to the extent the law allows. Please write or call for a list of available publications.

Negative Population Growth, Inc.
2861 Duke Street, Suite 36
Alexandria, VA 22314

Voice: (703) 370-9510
Fax: (703) 370-9514
email: **npg@npg.org**
www.npg.org

SIGN UP TODAY AT WWW.NPG.ORG
FOR OUR NEW INTERNET *NPG JOURNAL*!