Fracking is NOT Good for Us

"We do not inherit the Earth from our Ancestors,

We borrow the Earth from our Children"

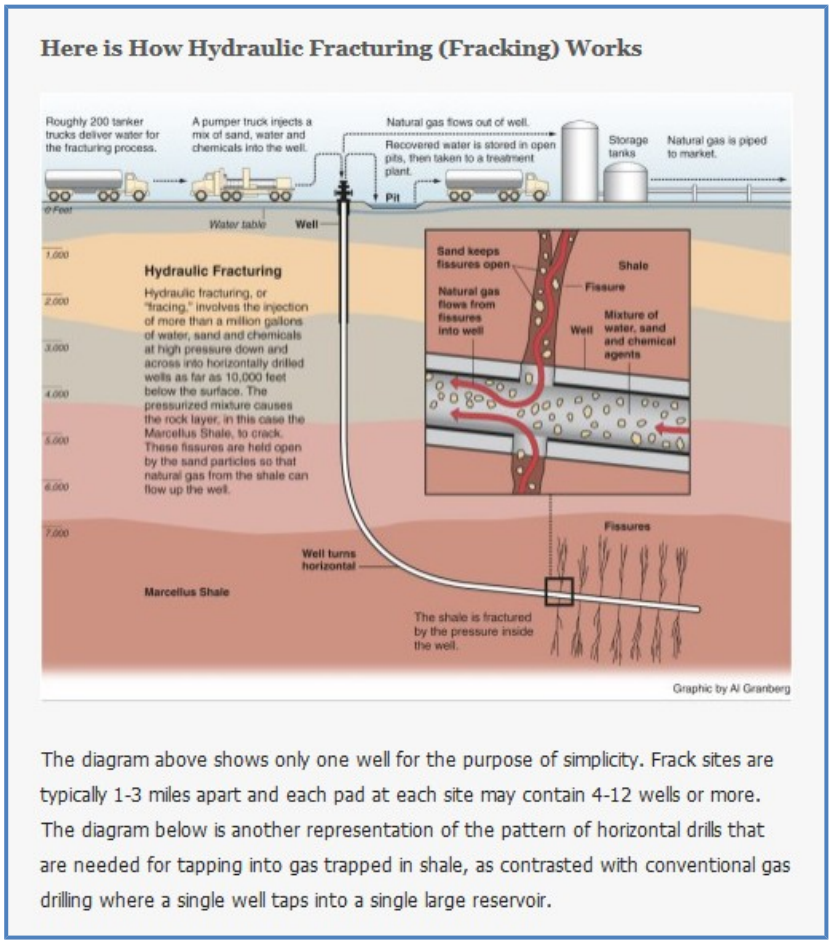
by Moss Cass

(Australian minister Environment and Conservation 1972-1975)

1 Fracking

When talking about fracking we mean the fracking of unconventional gas (UG). And this talk is mainly about shale gas. In fact in the USA most fracking is done in shales , e.g. Bakken basin (520,000 km^2) and Marcellus basin (260,000 km^2).

In a conventional gas well you may frack around the single well to improve flow. UG gas is confined in shales that are not very permeable. In UG the whole shale horizon has to be made permeable in order to get the gas out. Fracking is a mechanism to make the shale permeable (Fig 1.1). Therefore many holes have to be drilled horizontally to cover the entire shale horizon targeted (an example in Fig 1.2).



The diagram above shows only one well for the purpose of simplicity. Frack sites are typically 1-3 miles apart and each pad at each site may contain 4-12 wells or more. The diagram below is another representation of the pattern of horizontal drills that are needed for tapping into gas trapped in shale, as contrasted with conventional gas drilling where a single well taps into a single large reservoir.

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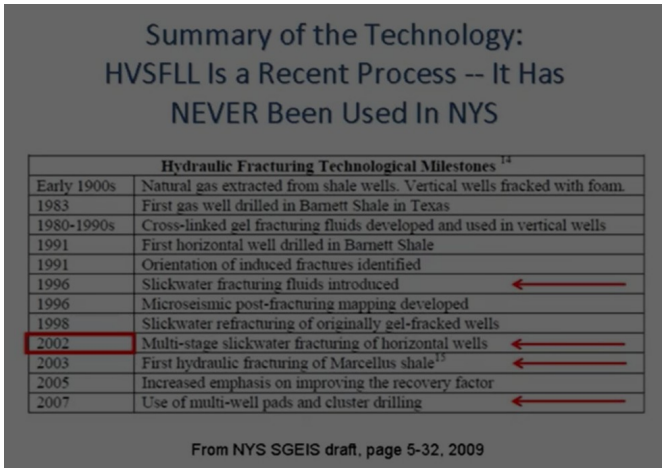
http://brigittavaradi.squarespace.com/talk-about-fracking/

Fig 1.2



Summary of the Technology:
HVSFLL Is a Recent Process -- It Has NEVER Been Used In NYS

Hydraulic Fracturing Technological Milestones [14]	
Early 1900s	Natural gas extracted from shale wells. Vertical wells fracked with foam.
1983	First gas well drilled in Barnett Shale in Texas
1980-1990s	Cross-linked gel fracturing fluids developed and used in vertical wells
1991	First horizontal well drilled in Barnett Shale
1991	Orientation of induced fractures identified
1996	Slickwater fracturing fluids introduced
1996	Microseismic post-fracturing mapping developed
1998	Slickwater refracturing of originally gel-fracked wells
2002	Multi-stage slickwater fracturing of horizontal wells
2003	First hydraulic fracturing of Marcellus shale[15]
2005	Increased emphasis on improving the recovery factor
2007	Use of multi-well pads and cluster drilling

From NYS SGEIS draft, page 5-32, 2009

2 Land disturbance

As explained in section 1 many wells have to be drilled and the impact of this on the landscape can be seen in Fig 2.1. This is in the USA but similar images can be found in Australia (Fig 2.2). The scale of the land disturbance depends on the number wells from one drillpad or a separate drillpad for each hole.

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The movie *Promised Land* depicts the dilemma faced by rural farms and towns by the fracking boom. While the makers of the film do reveal their biases in terms of the potential environmental and economic exploitation of poor, rural America, they attempt to provide a balance of perspectives that include some surprising twists with the conclusion left up in the air. Although we don't actually see fracking or the results of it in the film, here is what a fracked landscape looks like.

Fig 2.1

Fig 2.2

3 Chemicals

In the fracking process many chemicals are used. The companies involved always say the percentages of chemicals used are very low and that is true. What they do not tell you is that with the enormous amounts of water used the absolute volumes are large (Fig 3.1). The chemicals are transported to site in tanker trucks not in suitcases. Below some quotes about chemical usage.

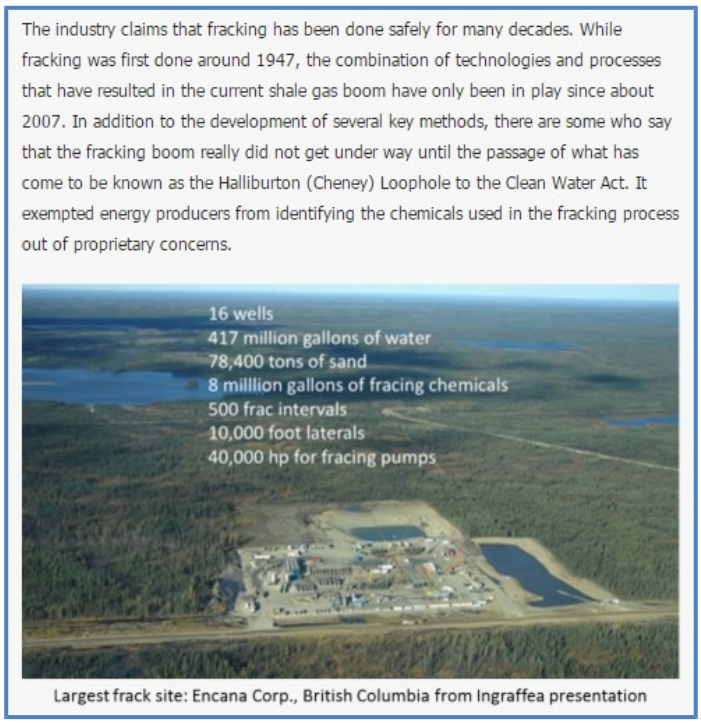

Fig 3.1

Between 2005 and 2009, the 14 oil and gas service companies used more than 2,500 hydraulic fracturing

products containing 750 chemicals and other components. Overall, these companies used 780 million gallons (2.9 Billion liters) of hydraulic fracturing products – not including water added at the well site – between 2005 and 2009 (US-Congress_Hydraulic-Fracturing-Report_2011-4-18).

"Chemicals are used at most stages of the drilling operation to reach and release the natural gas from gas coal seams – to drill the bore hole, to facilitate the actual boring, to reduce friction, to enable the return of drilling waste to the surface, to shorten drilling time, and to reduce accidents. After drilling has been completed, hydraulic fracturing is used to release the trapped gas by injecting approximately 2.5 million litres or more of fluids, loaded with toxic chemicals, underground under high pressure." (Theo Colborn, Carol Kwiatkowski, Kim Schultz, Mary Bachran : Natural Gas Operations from a Public Health Perspective, International Journal of Human and Ecological Risk Assessment, September 4, 2010) [i].

In the enclosed document "Toxic Chemicals in Unconventional Gas Exploration and Production" is a short list and explanation of some of the chemicals used. I am not a toxicologist but most listed do not look very appetising.

4 Water

A lot of water is used during the drilling process. The enclosed table "Fracking Well Water Usage" shows the various scenarios of water usage. All that water is drawn from local aquifers. These aquifers are the source of all the water the local communities and environments needs.

Dick Cheney (vice=president under GW Bush) didn't care about public safety but he did care about Halliburton's (note : Halliburton and Schlumberger are the two largest oil & gas contractors in the world) bottom-line - after all, he was a big Halliburton stockholder when he became vice president - and so he joined the lobbying efforts to get Congress to carve out an exemption for fracking in the Safe Water Drinking Act. Thanks to that carve the EPA can't regulate fracking poisons even when they get into our water supply [ii].

It has set a precedent, as a result so much fracking is done in the US. Most fracking related information comes from there and so the argument that it should all be fine in Australia.

All the tracks created and used to access the drill sites need to be water down for dust suppression. With a spray rate of 4 liter /m2 , a track width of 7m that means 28 kiloliter per kilometer (about 10.2 Mega liter per year). Four liter is necessary for ground to retain the moisture., anything less will just evaporate and does not do anything for dust control.

5 Geology

In conventional gas reservoirs if faults would leak all gas would have escaped by now. In UG shale, because the gas is trapped in the shale itself there could be one or more leaking faults in the reservoir block. The reservoir holds the gas because the shale is impermeable. But when the shale has been fracked and the gas starts flowing it can escape along the "open leaking" faults. Besides the gas leaking also the toxic fracking fluids can leak via these faults. The same for the re-injected contaminated water at various stages of the program.

In order to make rocks fracture the fluids pumped in at a pressure much higher than the static pressure at the depth of drilling. This very high pressure may also reopen existing old fractures which could form conduits for the toxic fracking fluids to travel upwards and possibly contaminate aquifers. Fig 5.1 shows

pressures possible induced seismicity along pre-existing faults caused by fracking. But most seismicity is apparently caused by re-injecting the frack fluids. How detailed is the fault geology known to make and what is known about the rock mechanics especially related to stress. When rocks of an area are critically stressed faults in this zone could reopen. From an operational viewpoint to successfully frack the stress fields have to be known

Faults can easily extend from drilling depth to closer to the surface and intersecting aquifers (see Fig 5.2). What is the certainty that various aquifers are not interconnected? Even if the aquifer is salty that should not be a licence to pollute it with toxic chemicals. Leaking wells can be plugged but leaking faults will **leak forever**.

Operators and government state that everything will be done according to "best practices". But best practices are only improved after stricter regulations. Stricter regulations come only into play after a disaster. So using these phrases to justify fracking or anything else for that matter is not a very responsible reason.

Because staged approach starting off with just one exploration well then when successful more are planned. Seismic surveyed would have provided a reasonable accurate dimension of the potentially gas bearing shale, otherwise it is just wild-catting. Once exploration is deemed to be successful a series production wells will be drilled and so fracking will continue until the whole of the outlined shale horizon has been drilled and fracked. There is nothing controversial with this approach, one cannot expect companies to know in advance where exactly they will be drilling next. It is the e most efficient way of conducting the program. However they should be able to give a indicative range of how many holes and which area could be drilled when the program is successful.

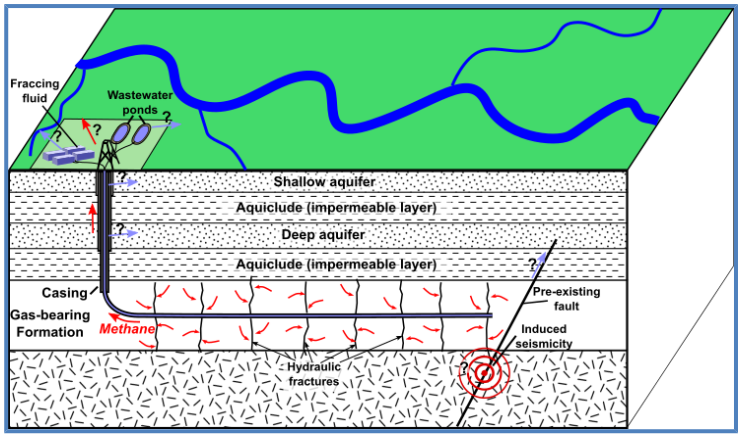

Fig 5.1

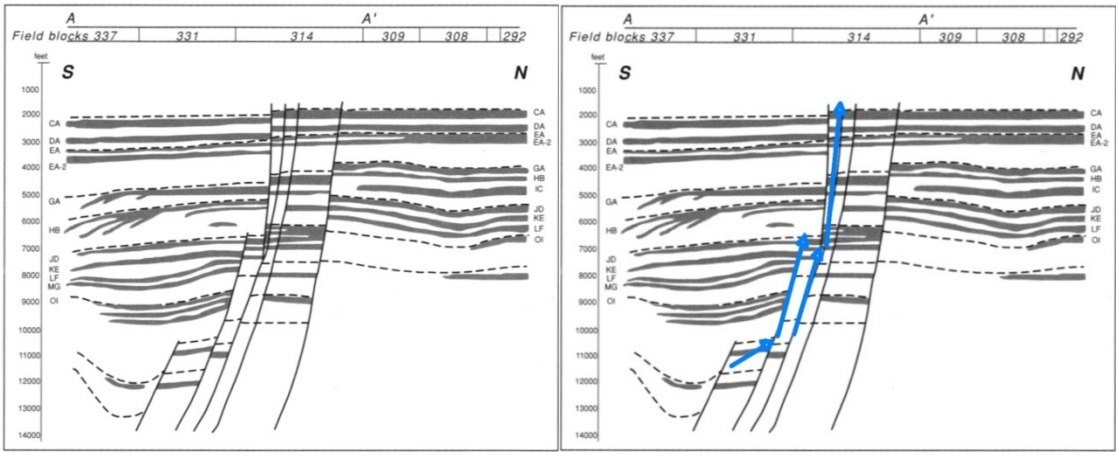

Fig 5.2 above : On left the interbedded shale, sandstone layers and some faults in center. On the right the blue arrows indicate possible pathways along faults from lower levels. So from 3,500m (11,000ft) deep to the shallower depth of 600m (2000ft).

6 Risks

'UG exploitation and production may have unavoidable environmental impacts. Some risks result if the technology is not used adequately, but others will occur despite proper use of technology. UG production has the potential to generate considerable GHG emissions, can strain water resources, result in water contamination, may have negative impacts on public health (through air and soil contaminants; noise pollution), on biodiversity (through land clearance), food supply (through competition for land and water resources), as well as on soil (pollution, crusting).' (UNEP Global Environmental Alert System 2012)

Whenever drilling through an aquifer (salty or fresh) there is a risk of contamination. Due to leakage during the drilling stage. In conventional gas drilling only a few holes are drilled, as pointed out above in the tight shale gas fracking many holes are drilled. Therefore the risk of contaminating aquifers is multiplied by the number of holes drilled. In WA they talk about 10,000 to 100,000 wells. A conventional well is planned for 25 years plus. Fracking wells are planned for 5 – 10 years. This means that the quality of the well casing and seals are rated for that period and therefore the quality will be less resulting in an increased risk of leakage.

Leaking well can be plugged look at the BP's Deepwater Horizon drilling rig in the Gulf of Mexico in 2010. But faults cannot be plugged when they leak.

7 Economics

Governments and their regulatory system one looks only at short economic financial benefits, this is true for business as a whole. There are no long term benefit analyses done. The economic parameters seen to be always short term. Like the expansion of the Shensua coal mine on the Liverpool planes situated on prime agricultural land. Let say 30 year profits is more important than hundreds of years agricultural production?

For how long is the gas company responsible for the well integrity and other environmental issues. What happens when the company goes broke or is overseas based and does not operate in Australia anymore. Who will fix the problem and pay for it?

If gas companies are so confident that all is ok why do they not take out insurance for the risk covering at least 50 years. If the risks are low as the companies claim that the premiums will be low too.

Are short term and long term effects on environment and people ever be put in the cost benefit analysis? It is the role of any government to look at these issues. And if they do not that industry is not going to provide them.
As with any business or engineering proposal all impacts have to be taken into account Fifty years ago certain practices may have been acceptable but not in 2015. An example is that the original "FreightLink" freeway through the Beeliar Wetlands was acceptable originally years ago but not now in 2015 with all the knowledge about their importance it is not acceptable.
Below some quotes from the financial industry about fossil fuels :

HSBC Advises Clients Against Fossil Fuel Investment. "*The bank wrote to its clients that fossil fuel companies will become "economically non-viable"* (http://time.com/3840005/hsbc-clients-fossil-fuel-investment/ , April 29, 2015).

Big power out, solar in: UBS-Bank urges investors to join renewables revolution World's largest private bank predicts large-scale power stations will soon make way for electric cars and new solar technologies. In a briefing paper sent to clients and investors this week, the Zurich-based UBS bank argues that large-scale, centralised power stations will soon become extinct because they are too big and inflexible, and are "not relevant" for future electricity generation. Instead, the authors expect it to be cheaper and more efficient for households and businesses to generate their own energy to power their cars and to store any surplus energy in their own buildings even without subsidies. (
http://www.theguardian.com/environment/2014/aug/27/ubs-investors-renewables-revolution)

Leading investment bank UBS says the payback time for unsubsidised investment in electric vehicles paired with rooftop solar and battery storage will be as low as six to eight years by 2020, potentially triggering a massive shift in the energy industry. https://www.greentechmedia.com/articles/read/ubs-time-to-join-the-solar-ev-storage-revolution

Citibank: *Renewables will get bulk of world's new power investment.* (10 October 2013, http://fuelfix.com/blog/2013/10/10/citibank-renewables-will-get-power-investment-will-be-clean-by-2025/#13370101=0)

Utilities Switch Off Investment in Fossil Fuel Plants (http://www.nytimes.com/2013/06/19/business/energy-environment/utilities-switch-off-investment-in-fossil-fuel-plants.html?_r=0)

Weighing the Risks of Investing in Energy Companies. Nordic country's largest private pension fund manager Ms. Meisingset and Storebrand, which manages about 500 billion kronor, or about $74 billion, are among the fund managers beginning to think skeptically about fossil fuel companies — not so much because they or their clients disapprove of their activities, but because they think the securities issued by these companies may prove poor long-term investments. The reasoning, which has caught the attention of major oil companies like Royal Dutch Shell, is that after a period of relative inaction, world governments may be heading toward adopting tougher rules on emissions, transforming the economics of the energy business. (http://www.nytimes.com/2014/06/12/business/international/weighing-the-risks-of-investing-in-energy-companies.html)

From Hurricane Sandy's devastating blow to the Northeast to the protracted drought that hit the Midwest Corn Belt, natural catastrophes across the United States pounded insurers last year, generating $35 billion in privately insured property losses, $11 billion more than the average over the last decade. And the industry expects the situation will get worse. "Numerous studies assume a rise in summer drought periods in North America in the future and an increasing probability of severe cyclones relatively far north along the U.S. East Coast in the long term," said Peter Höppe, who heads Geo Risks Research at the reinsurance giant Munich Re. "The rise in sea level caused by climate change will further increase the risk of storm surge." Most insurers, including the reinsurance companies that bear much of the ultimate risk in the industry, have little time for the arguments heard in some right-wing circles that climate change isn't happening, and are quite comfortable with the scientific consensus that burning fossil fuels is the main culprit of global warming. "Insurance is heavily dependent on scientific thought," Frank Nutter, president of the Reinsurance Association of America, told me last week. "It is not as amenable to politicised scientific thought." Yet when I asked Mr. Nutter what the American insurance industry was doing to combat global warming, his answer was surprising: nothing much. "The industry has really not been engaged in advocacy related to carbon taxes or proposals addressing carbon," he said. While some big European re-insurers like Munich Re and Swiss Re support efforts to reduce CO2 emissions, "in the United States the household names really have not engaged at all." Instead, the focus of insurers' advocacy efforts is zoning rules and disaster mitigation. (http://thinkprogress.org/climate/2013/05/15/2013351/may-15-news-insurance-industry-heavily-dependent-on-scientific-thought-see-rising-climate-costs/)

Investor Expectations: *Oil and Gas Company Strategy. Supporting investor engagement on carbon asset risk* (http://1gkvgy43ybi53fr04g4elpcdhfr.wpengine.netdna-cdn.com/wp-content/uploads/2014/12/2014-Investor-Expectations-Oil-and-Gas-Company-Strategy.pdf)

By Royal Appointment - 5 Signals For Investors To Heed As Paris Climate Talks Draw Near.

As the Paris climate talks draw ever nearer, the Prince of Wales has warned that the time is now *"to create the secure future we all want for our children and grandchildren"*. He also said *" all investors must decide if they are future takers or future makers"*.

Mark Lewis, the new head of utilities research at Barclays, highlighted how quickly things can change by explaining what has happened in the utilities. *"This is a transition that is well advanced in utilities. Primary energy demand in the EU is at 1990 levels despite the accession of the energy-intensive Eastern European countries. But 10 years ago, you would have struggled to find any research saying that some of the biggest companies out there would fall by 60-80%. We talk as if stranded assets is a hypothetical. It isn't."*
The impact of renewables on the sector has been more disruptive than anyone saw at the time, he added, because strong support from European governments led to massive investment in the solar sector in China that saw the price of solar power plummet.
"*The power of business-as-usual is enormous,"* he added. "*But the tide is only moving in one direction. You can swim in whatever direction you like, but the direction of the tide is clear."*

http://www.forbes.com/sites/mikescott/2015/10/30/by-royal-appointment-5-signals-for-investors-to-heed-as-paris-climate-talks-draw-near/

Questions unanswered :

Both government and industry when supporting projects they mention best practices and tough regulations. Best practices are designed and updated after regulations have been tightened up. Regulations become more strict after a mishap or disaster has happened.

Before starting fracking project questions have to be asked, a few are listed here :

- Is there a need for the gas produced in a few years time? With the rise of renewable energy there maybe no need for all that gas, keeping in mind that tight shale gas would be on the higher end of the cost curve. There should be enough conventional gas available to supply the demand.
- The chemicals used in fracking how harmful are they to humans and nature in general? What do the toxicologists say about it? Have base line studies been done?
- How much water will be with drawn from shallow aquifers during the drilling process? What impact is there when these shallow aquifers are dried up because of excessive water extraction by fracking companies? What will happen to the communities that have their aquifers depleted or contaminated?
- What risks are associated with drilling so many through the various aquifers?
- Is the rock stress regime and critical rock stresses well enough understood to model potential fault reactivation?
- After initial exploration success how many more holes will have to be fracked if the field goes in to production till the end of its life?
- What is the cost of upkeep after the well have been abandoned? For how long? Who pays for that? Is bond paid high enough to do this?
- What is the overall impact on the environment and society. What will the cost be of this impact?
- Are the risks associated with fracking worth the gains.
  - To Summarize
    - The sort term risks convert to gains are to the benefit of the company
    - The long term risks is borne by the public/taxpayer.
- Can we believe the oil & gas industry in relation to fracking? It is doubtful since revelations that they (Exxon) knew about climate change 40 years ago.

Conclusion

At a glance fracking looks all under control and ok. However, once all positives and negatives are tabled, fracking for UG does not stack up.

It might have been a good idea 30 years ago but now at the start of the TiR[iii] there are better ways to get energy which will be much cleaner. Going to renewable energy will mean also for a country and consumer that no volatility of oil prices will effect energy supply.

And if still not convinced go to insurance companies and ask them if they want to insure fracked wells and their impacts on the environment for the next 50 years and/or 100 years and what the premium will be.

Links & Bibliography

Mary Robinson : ex-president of Ireland and commissioner at UN. Excellent presentation
http://www.ted.com/talks/mary_robinson_why_climate_change_is_a_threat_to_human_rights?share=19937ae635

Exxon knew about climate change 40 years ago
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i http://www.endocrinedisruption.com/files/NaturalGasManuscriptPDF09_13_10.pdf quote copied from NTN-CSG-Report-Sep-2011.pdf).

ii http://www.theecologist.org/blogs_and_comments/commentators/2280541/time_to_end_the_cheney_halliburton_loophole.html
https://www.washingtonpost.com/posteverything/wp/2014/12/12/dick-cheney-wants-you-to-know-he-doesnt-care-what-you-think/

iii TiR : Jeremy Rifkin's

- *Third Industrial Revolution, How Lateral Power Is Transforming Energy, the Economy, and the World* (2011)
- *The Zero Marginal Cost Society : The Internet of Things, The Collaborative Commons and the Eclipse of Capitalism* (2014)