METHANE

1.0 INTRODUCTION TO METHANE

We know that the natural methane cycle involves natural sources of methane stemming from the anaerobic decomposition of decaying matter that is found in wetlands together with animal and termite digestion. The methane itself decomposes into CO_2 with a 12-year half-life. Before industrialization, the global methane source-sink balance was stable. The natural and anthropogenic sources of methane are depicted in Figure 1.

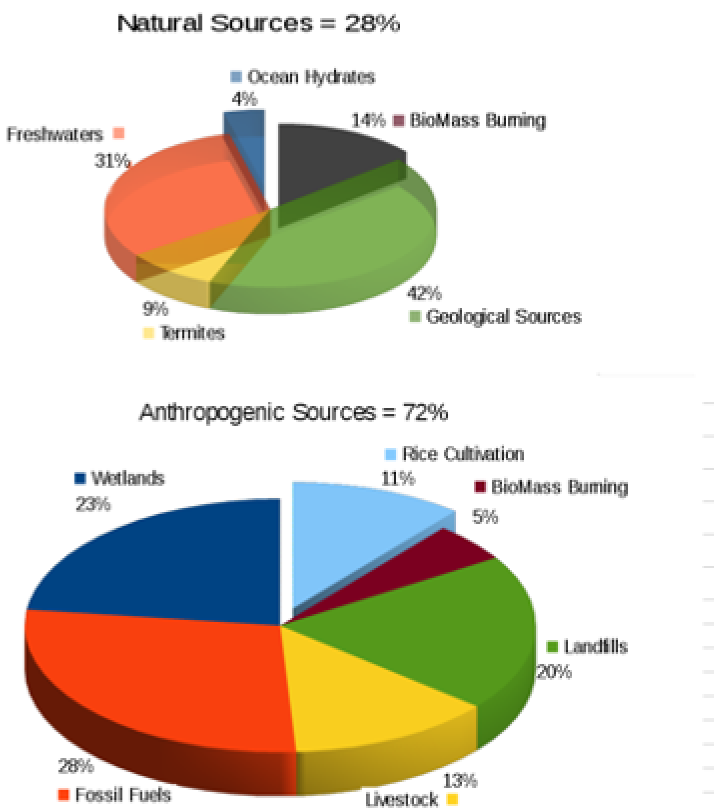

Figure 1 Sources of Methane

Since methane is such a powerful Greenhouse Gas, with 84x more global warming capacity than CO_2, it is possible for human-sourced methane to overdrive the planet's natural balance. Global warming is the response to the combined effect of accumulated CO_2 and CH_4 (methane) plus other pollutants.

Natural sources also include the release of methane captured in decayed matter frozen into permafrost in the Arctic. With the high increase in average annual temperatures in the Arctic (+5F), the natural response is to release that captivated methane.

We find in Figure 2 that the trend, before significant artic methane release, is toward increasing concentration every year, despite the CH4 half-life. The risk of a sudden release of Arctic methane in response to increasing Arctic temperatures would further increase GHG-driven Arctic methane releases. We do not know for certain how close the planet is to the Arctic temperature where methane release starts tipping uncontrollably past its current retention state.

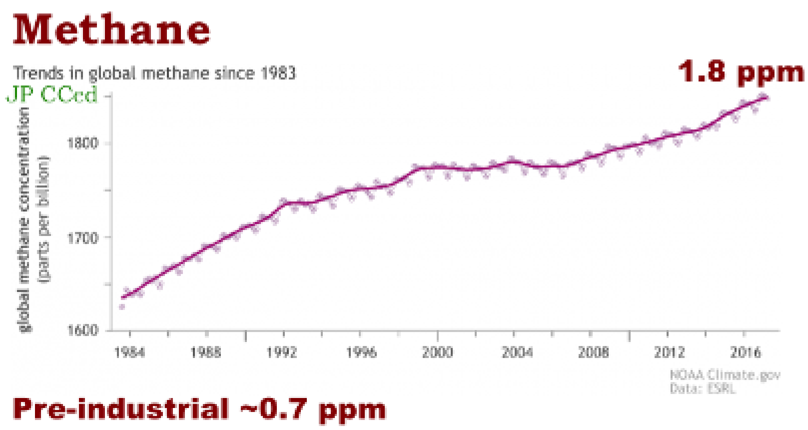

Figure 2 Methane Concentration History

Some evidence points to 1.5 deg C as a likely threshold for permafrost melt. An examination of caves in Siberia found geologic evidence that permafrost melting occurred at 1.5 deg C above the historic average temperature (New Scientist). Regarding the possibility of a methane runaway tipping point temperature, the same experts opined no risk, with no evidence given, because soil microbes consume some methane. This was before methane started forming post-blowout craters in Siberia.

The phrase “Methane Bomb” or sometimes “Arctic Methane Bomb” refers to a huge risk for an event that we can’t accurately forecast. It has the opportunity to rip control away from humans and finish heating the planet past supporting life as we know it. As the video clip below puts it; If nature starts putting out global warming gasses as fast as humans are, now, then it will no longer save the situation for humans to stop putting their share out. It is a real risk, and should bring an urgency to attempts to stop CO2 emissions that has not been in anyone's serious planning, yet.

The issue is that a huge amount of methane has been stored in the arctic over millions of years. This was necessary to switch life on earth from anaerobic life (organisms for which oxygen is a poison) to aerobic life (organisms like us that breath oxygen). Almost all current animal life forms are aerobic, and they depend on the oxygen-tolerant plants on land and in the ocean to resupply the oxygen that we breath.

2.0 AN EMERGENCY MANAGEMENT PLAN FOR THE ONSET OF METHANE RUNAWAY.

Given the dire consequences of exceeding the unknown Arctic Tipping Point temperature, a corporate-style risk management plan would be advisable. There is no such plan as we drive our planet forward into a risky unknown future. Maybe we should start one.

2.1 Risk Analysis

Human-sourced methane (65% before the tip) could conceivably be controlled and cut faster than the Arctic methane tips out. Which sources are controllable? The extent of controllability is depicted in Figure 3.

Rice cultivation cannot be stopped under any conceivable circumstances, nor waste decomposition, nor enteric methane from domestic ruminants. That leaves fossil fuels (29% of human sources) and biogas burning (14% of human sources), for a total of 43% of human sourced methane. This equates to 28% of all methane sources.

You would think there would be settled science on these existential questions. There is no question in science that is more consequential that that for runaway methane. It remains open and neglected. Even if you are not a problem gambler, but no definitive answers to these two existential situations, there is still **no choice but to make worst-case contingency plans.**

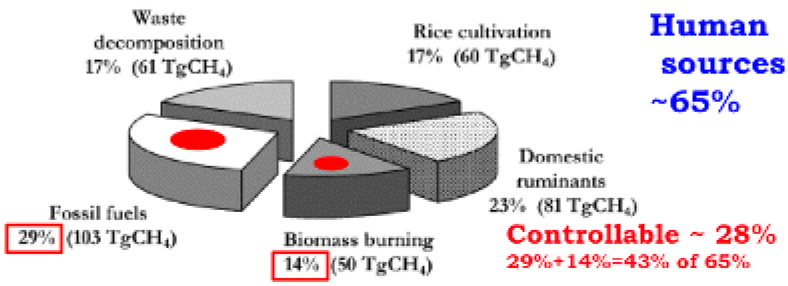

Figure 3 Methane Concentration History

The range of control is 28%. A spike in Artic methane that occurs before human sources can be cut would render the climate uncontrollable – just think about the math, not the extinctions. To date, no controls have been demonstrated even without a postulated methane crisis.

2.2 Risk Management

Permitting an exceedance of the unknown Artic Tipping Point Temp is not management of risk. Foreclosing the possibility of this exceedance is.

How would this foreclosure occur? The market for natural gas is well established but not well understood, given the inability to predict natural gas market valuation. The most obvious steps are no surprise.

Step 1

Perform gas infrastructure end-to-end Leak Detection and Repair (LDAR). There is no industry mandate to accomplish this (neither from regulators or civic-minded stakeholders). The only attention to this critical issue is from the US Government Accounting Office (GAO) report:

(1) Defines levels of performance and address all core program activities and
(2) Uses budget data to refine performance goals for its gas storage program.

This GAO report has been issued in response to the discovery of unreported long term methane leaks like the Sabine Pass LNG Export Plant. (Shutdown)

Extensive infrastructure repair would be necessary for certification of a leak-free gas grid. The current gas grid is too leaky to take advantage of renewable natural gas (RNG). Leaking RNG, thereby defeating its climate benefits, is categorically insane under the current methane threat. So too would be the proliferation of back yard biodigesters – they must be outlawed with severe penalties. Survivalists take note.

Step 2

Locate and cap all abandoned gas well bores. There is no industry mandate to accomplish this (neither from regulators or civic minded-stakeholders). The number of unlocated rogue wells is astounding.

Step 3

Target a gas price that is 2x the average from the last 10 years. Start shutting down well production until this price is reached. This is a measure of market sensitivity, currently unknown, that balances market demand against the unknown Tipping Temperature margin. This is the Tillerson-Tipping pain index for possible emergency methane shutdown of all gas and oil methane sources on the planet. No one can prove that this will never be necessary. And it’s possible that this could be sufficient to avoid dire consequences – if managed. BTW there has been no management, is no management, and there will be no management until beneficial authority is instituted. The proof of “no management” is abundantly evident in Figure 4.

Step 4

Biogas burning would possibly offer sustainability advantages were it not for the Artic threat, so a categorical biogas shutdown is unavoidable.

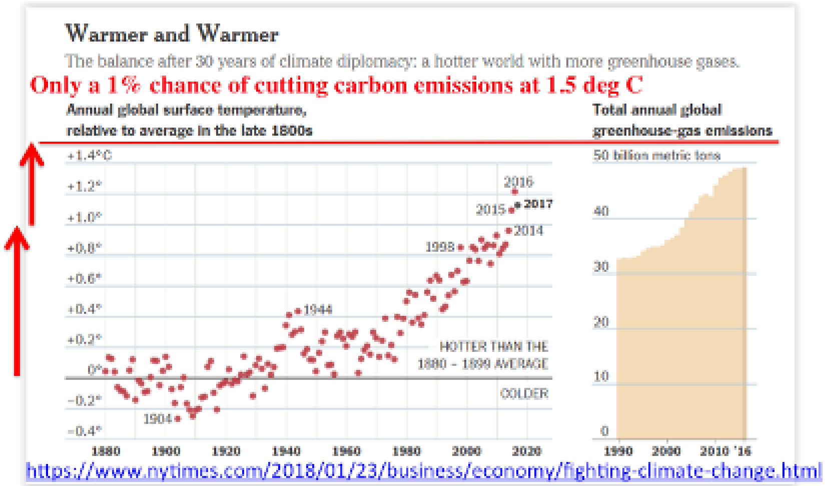

Figure 4 Climate policy work has had no measurable effect for 40 years

2.3 Risk Mitigation Math

We can understand in general terms what happens when a methane source is cut. Take a plume of methane that has been released for a day and then cut off completely. After 12 years the original plume is half what it was, because half the plume has dissipated into CO2. Another 12 years and it is down another half. At what point is it down to 1/84th of the original amount? When it has completely dissipated into CO2.

The math says for all practical purposes this takes 73 years, as depicted in Figure 5, which shows the lifetime of a single plume of CH4 released into the atmosphere. The strength of that plume declines in each subsequent year, shown as blue bars.

The next question is, if the one-day plume has dissipated, and we know this helps the planet, when does the average global temperature respond by declining to some extent? This math is less intuitive and the question probes another unknown – climate sensitivity. The best we have is a collection of models (you should believe in models – you have nothing better).

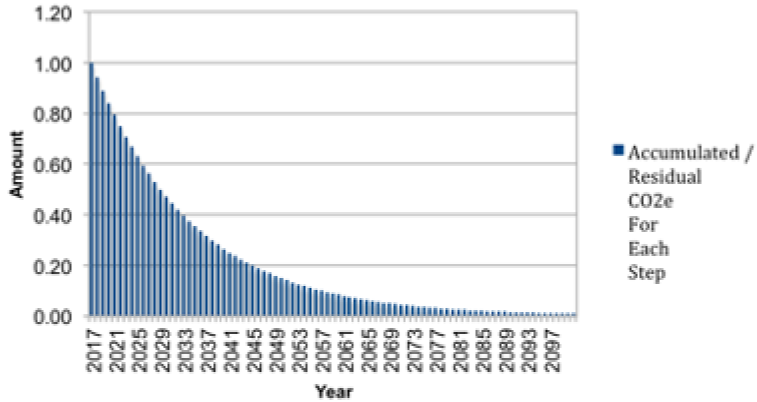

Figure 5 Lifetime of a Methane Plume

One blogger report suggested that the time for Earth to respond to increasing climate pollution is 40 years, a Climate Lag due to the heat retention of ocean waters. The lag time for cooling is no different from that for heating. From extensive modeling of this cooling delay, we now think it takes 30 years for the Earth to get better if you take away a climate-forcing factor (CO_2, CH_4, or some other pollutant). (Climate Lag Models). This response, though it needs more work because it is such a poorly known and survival-critical behavior, is given only approximately as shown in Figure 6.

3.0 SUMMARY OF RISK MITIGATION MATH:

1. Heat trapping capacity of a methane plume becomes extremely small in about 70 years.
2. Methane is controllable.
3. The Earth responds in 30 years if you cut all methane tomorrow.
4. Chances are that Arctic methane will tip out in the next 30 years while waiting for global average temperature to peak and start declining.
5. The longer methane is allowed to feed GHG concentrations, the more likely methane runaway will exceed anyone's ability to stop it.
6. **While we must continue to wait for any carbon sequestration technology to be demonstrated economically at scale, the only option available is to shut down all methane extraction and hope for the best.**