Any Progress on Climate ?

Testimony in Support of Oregon House Committee on Energy and Environment
HB 3343 Climate Test

Preface

What do we know about Climate?

In the first half of this paper, we will actually calculate prospects of limiting average temperature increase to 2 degrees C. We do this by using numbers reported in the public domain and taken from the best science. We express these numbers using simple math to produce basic graphics. Going by these data we confidently draw some compelling conclusions.

In the second half we discuss some aspects not yet proven from known facts and numbers. What we don't know with total exactness can still be enough to point to equally compelling conclusions. Moreover it can very important to acknowledge those very unknowns that we must insure ourselves against.

NW Climate Methane Task Force

10 April 2017

Test Your Understanding of Progress on Climate

Was there much to learn about the climate problem from the 2016 US Presidential Campaign? Well actually no, climate was not debated during primaries, or in the general election campaigns. Has the media tracked the accumulation and disclosure of data, surprises, trends, and forecasts? No Pulitzers here.

Our effort is to connect a lot of accepted science data we collected from publicly available fragments and assemble a big picture of where we think we are in early 2017. Other authors have not done this to date, making our picture new to most readers. So see what's new to you.

The UN Emissions Gap Report, 2014

Although many of us are hoping optimistically for the best outcome from interventions to preserve historical climate patterns, the UN IPCC has identified specific goals that are within reach to accomplish this. The temperature limit that can be attained is 2 ^{0}C above the known average surface temperature from 1850. This "set point" determines the amount of Greenhouse Gas (GHG) like carbon dioxide (CO2) that can be added to the global environment and still not exceed 2 ^{0}C.

The Emissions Gap Report 2014 published in November that year by the UN Environment Programme (UNEP) [NOTE 1] identifies the amount of carbon that can be added to the environment by human activities, starting in 1850 without exceeding 2 ^{0}C: it is 2,900 GT (gigatons) of CO2. Once the 2,900 GT budget is expended, the amount of allowed carbon release is zero. This event determines the carbon neutrality date and according to the UNEP report it might be achieved as early as 2055. UN data relationships are depicted in Figure 1.

NOTE 1: http://edgar.jrc.ec.europa.eu/docs/The_Emissions_Gap_Report_2014-November_2014EGR2014_LOWRES.pdf

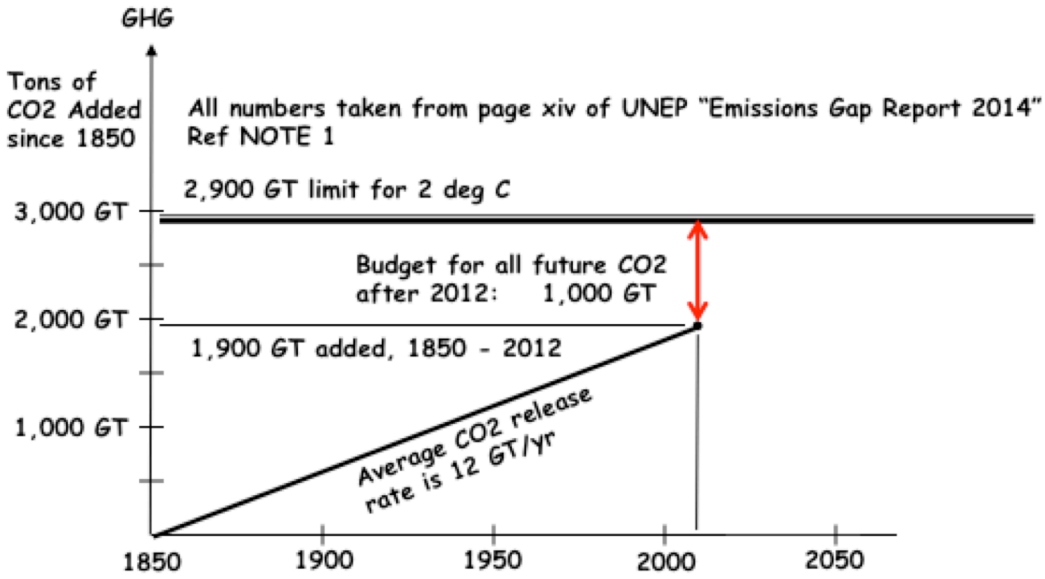


Figure 1 Best science describing Earth's future carbon cycle limit

From here on, the maximum carbon release allowable annually can be computed from dividing the remaining budget by the 38 years remaining to 2055. Since 1,900 GT have already been released without being reabsorbed, the remaining budget for a 66% chance of staying under 2 ^{0}C is 1,000 GT. The math gives us 1,000 / 38 = 26 GT per year between now and 2055.

The question occurs, how much CO2 is actually being released by human activity on the planet annually? Data has been obtained from the EDGAR database, which reports in 2015 the global total was 36 GT (not 26 GT annually, as cited in the UN report).
https://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions
If this trend continues, the 1,000 GT limit from 2012 onward will be reached by 1,000 / 36 = 28 years, i.e. 2040. The result of the current annual release rate is shown in Figure 2.

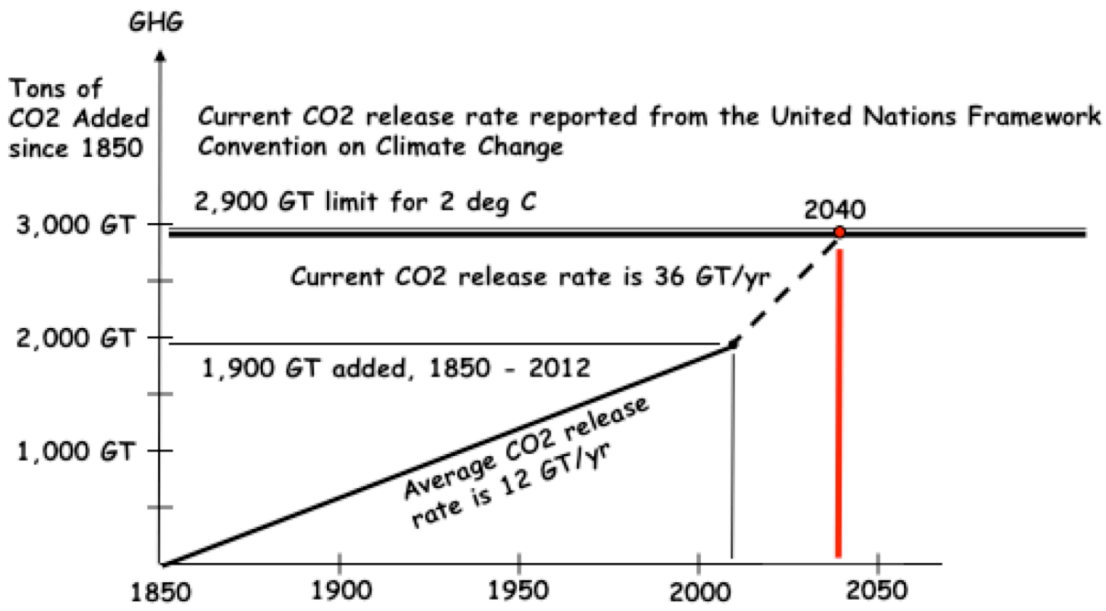


Figure 2 The net zero carbon date if current CO2 release rate continues is 2040

Other data sources report slightly higher CO2 emission in 2012 (38.68 GT), together with declining carbon budgets and less likelihood of staying below the desired 2 ^{0}C threshold.
https://docs.google.com/spreadsheets/d/1odltJu_rxabdVXv_pACMBNIRiFSkc_HqJn-V8z0av2w/edit#gid=731498129

What does this mean for Oregon?

Looking at annual CO2 emissions, the 2016 EPA inventory reports Oregon releases 38 mmt per year (million metric tons), which is 0.7% of the total 5.4 GT US CO2 emissions.
https://en.wikipedia.org/wiki/List_of_U.S._states_by_carbon_dioxide_emissions

Compared to global CO2 emissions, 36 GT, numerically our Oregon fraction is 0.1%.

The meaning of this number deserves some attention. It tells us we are confronted with an inescapable, incessant fallout problem for which policy changes or new legislation will have negligible numerical benefit globally. No direct mitigation is possible from here.
And the impact of CO2 climate damage is serious, with forecasts of 1.4% loss in US GDP, and approximate losses of $2B against Oregon's $218B GDP (2015), just to start with.

US: https://www.nrdc.org/sites/default/files/cost.pdf

Oregon: https://www.e2.org/wp-content/uploads/2016/07/Oregon_Business_Climate_Report.pdf

Research on the impact to global GDP says 20%.
https://www.brookings.edu/blog/planetpolicy/2015/12/09/the-global-economic-costs-from-climate-change-may-be-worse-than-expected/

If that's not bad enough, The Guardian forecasts trillions in financial losses.
https://www.theguardian.com/environment/2016/apr/04/climate-change-will-blow-a-25tn-hole-in-global-financial-assets-study-warns

Without exaggeration, the scale of such a dire discovery transcends any political crisis in recorded history, rendering partisanship totally incidental. Those still trying to make it partisan are shamelessly parading a narrow agenda in broad daylight.

You might ask yourself, what exactly is the root cause of this inescapable climate damage fallout guaranteed to literally change the face of the earth and ruin the ecological and economic future of EVERY community? And nothing Oregon tries to do will make any difference.

It's Worse Than We Told You

You may already know there are other climate-damaging pollutants besides CO2. After CO2, methane (CH4) is the second most important greenhouse gas contributing to human-induced climate change. Methane is responsible for 20% of the global warming produced by all greenhouse gases so far [NOTE 2].

The CH4 damage is more complicated than that from CO2 because it starts out very much more damaging, but then fades to only the same amount of damage as CO2. This occurs because the immediate warming property of CH4 is known to be 125x as effective as CO2. Then each 12 years half of it decays into CO2 + 2(H20). The 20% CH4 attribution accounts for decades and decades of mostly increasing CH4 emissions that fade over time. However, with continuously replenished amounts of CH4 discovered in the last few years, with its impact arriving just as we need to avoid reaching the 2 ^{0}C increase, the more recently emitted CH4 has an overbearing effect.

For a time horizon of 20 years, CH4 has a Global Warming Potential (GWP20) 84 times that of CO2. Since the 2 ^{0}C carbon neutrality date is the focus of carbon budget analysis, and is likely to occur within a 20 year time frame, we conclude the near term GWP20 property of CH4 must be acknowledged and its influence calculated.

NOTE 2: Global Methane Budget 2016,
http://www.globalcarbonproject.org/methanebudget/16/files/GCP_MethaneBudget_2016.pdf

It is important and accurate to use the methane GWP20 of 86x CO2 to determine its CO2 equivalent (CO2e), computing its effect from now to 2040. This makes CH4's current contribution rate to be approximately equal to CO2 as we run out of carbon budget margin.

From a close reading of the UNEP Gap Report [NOTE 1] the influence of CO2 and CH4 including other global warming substances originally set the 2 ^{0}C budget limit at 3,670 GT (see p xiv). When we add the serious climate damage of CH4 to the CO2 carbon budget graphic, this higher threshold must be shown.

In Figure 3 the 20% methane contribution to greenhouse gases is depicted as a new slope, for a total of 2280 GT CO2e in 2012.

1900 GT + 20% of 1900 GT = 2280 GT for CH4 in 2012.
12 GT / yr + 20% of 12 Gt / yr = 14 GT / yr for CH4.

The higher threshold for reaching 2 ^{0}C is depicted.

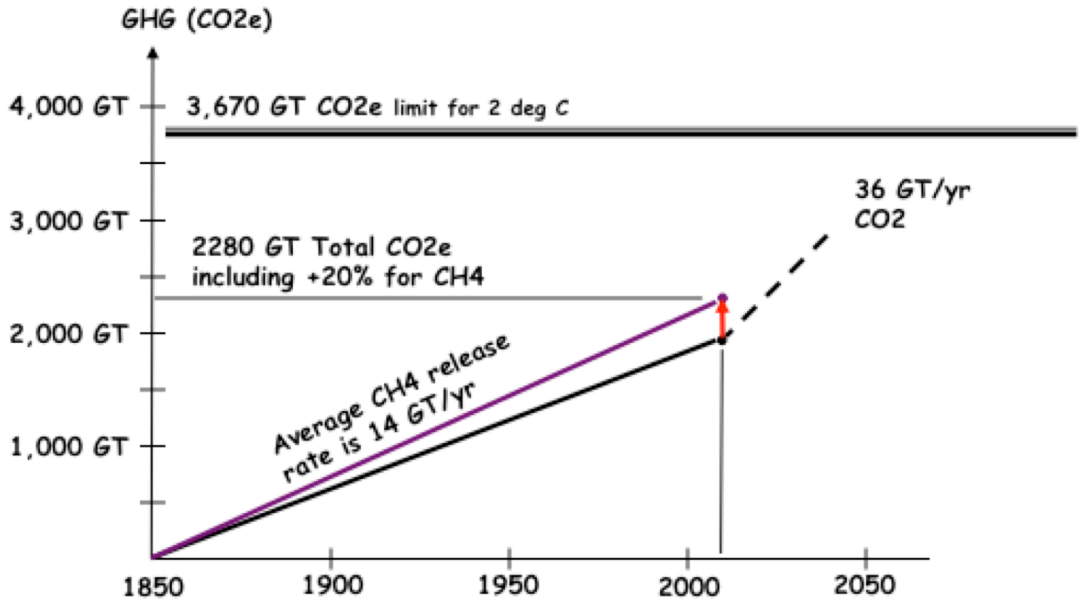


Figure 3 The CO2e threshold is higher when the effects of CH4 are added

In the 2016 Methane Budget report [NOTE 2] the emission rate of CH4 is identified separately from CO2, and can be found in the second plot on p12. Take the US EPA number for 2012 emissions as 348 Tg/yr from that plot. For our graph we need this rate expressed as GT per year.

US EPA CH4: 348 Tg/yr = 348 mmt/yr = 0.348 GT/yr (See conversion factors given on p7)

Factoring in GWP 20 for CH4, the CH4 emissions must be multiplied by 84 to represent the standard value for CO2e.

0.348 GT/yr x 84 = 29 GT/yr of CO2e emissions.

The 29 GT/yr of methane CO2e emissions are added to the CO2 emissions of 36 GT/yr, for a total emissions rate of 65 GT/yr. This higher rate reaches the higher threshold sooner than CO2 alone, in 2033 as shown in Figure 4. This analysis explains how quickly the chance to avoid excessive global temperatures is slipping away, in the face of a dire threat beyond state control.

(3670 GT – 2280 GT) 65 GT/yr = 21 yrs. From 2012 this is 2033.

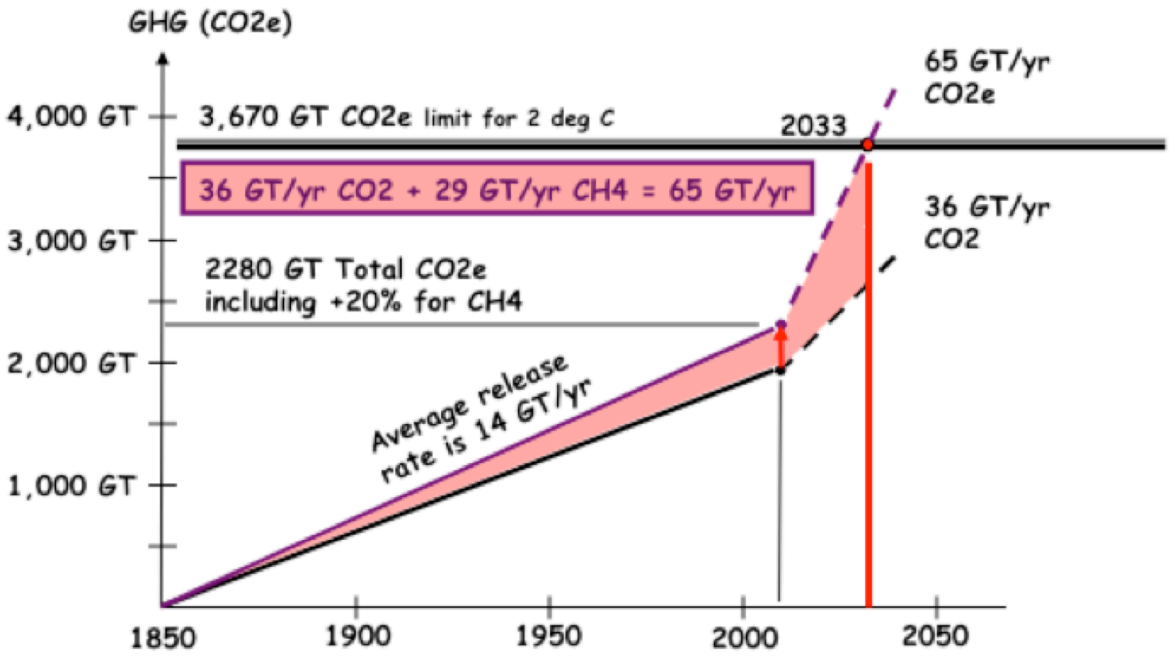


Figure 4 The net zero carbon date if current CO2e release rate continues is 2033

The root cause is this: a continued mindless support to carbon giants from publicly funded oil and gas subsidies, tax credits, below market leases of public lands, depletion allowances, while they deny any obligation to compensate the public for direct impacts to health and civic economic losses in terms of costs they conveniently externalize.

- Why do we pay with early credits like this, only to later pay the bill for the consequences of publicly funded endangerment?
- Why are we paying for government and not getting it?
- How can the executive branch rescind protections while ignoring this inexorable crisis unfolding on a planetary scale?

One must conclude that **the carbon budget is disappearing fast.** This has been carefully drawn from citing factual sources in the public domain to give a clear, best-available-science message, relying on basic math and simple, approximated graphics.

Below the double line our narrative is not mathematically rigorous, nor is all of it rigorously defendable from independently verifiable sources as is the first half of the paper. We believe that near term decisions must be taken without full knowledge, since very unfortunate natural events can occur without warning while science takes on the laborious process of consensus building for additional science-based analysis.

Stand By For Terrible News

Partial knowledge can be just as intimidating as fully calculated facts. There is good reason to believe that the interval to 2033 is rapidly being compromised.

"Because there are so many abandoned wells nationwide (a recent study from Stanford University concluded there were roughly 3 million abandoned wells in the United States) the researchers believe the overall contribution of leaking wells could be significant."
https://www.princeton.edu/main/news/archive/S41/80/71G06/index.xml?section=topstories

Rogue methane is escaping 24x7 from about 2.5 million abandoned oil and gas wells in the U.S., with about 20-30 million such wells globally.
http://www.boulderweekly.com/news/colorados-role-in-californias-porter-ranch-disaster/

There are 200,000 lost and abandoned gas and oil wells in PA, 220,000 in OH, 60,000 in LA, 50,000 in WY, 35,000 in CO.

PA: http://www.washingtontimes.com/news/2016/mar/19/abandoned-pennsylvania-gas-oil-wells-sought/
OH: http://www.ohio.com/news/local/ohio-making-big-effort-to-plug-600-orphan-gas-oil-wells-across-state-1.472487
LA: https://www.businessreport.com/article/bills-aim-address-thousands-louisianas-abandoned-oil-wells
WY: http://www.durangoherald.com/article/20160217/NEWS01/160219610/
CO: http://www.boulderweekly.com/news/colorados-role-in-californias-porter-ranch-disaster/

There are 885 orphan wells in CA, with 21,000 in idle inventory.
http://www.bakersfield.com/news/business/wells-without-owners/article_057fd3f5-b421-5f8e-894e-ce4ecf0caea8.html

Idle wells in CA are managed under statutory authority.
http://www.conservation.ca.gov/dog/idle_well

Elsewhere critical unknowns are pervasive. Only recently have methane super-emitters been identified, and there is no way to correlate them with unidentified abandoned wells (why? the well locations are unknown).
http://thehill.com/policy/energy-environment/291512-nasa-heavy-emitters-drive-southwests-methane-hot-spot

Cost to cap: $27M for 1350 wells in CA ($20,000/well).
http://www.naturalgasintel.com/articles/106727-california-renewing-effort-to-seal-abandoned-oilgas-wells

The news from the US EPA was always mixed. They accept mere estimates of methane leaks and releases from industry, no third-party verification of data, never required actual measurements for reporting national greenhouse gas inventories, and chose the irrelevant 100-year CO2e factor for CH4 that underestimates the near term high impact consumption of the remaining carbon budget. Even so, the rendering of the US EPA as an ineffective guardian of the planet is the stated goal of the current White House policy. With great effort and good fortune, some of the critical science and analysis databases may be preserved and protected to support future decision-making.

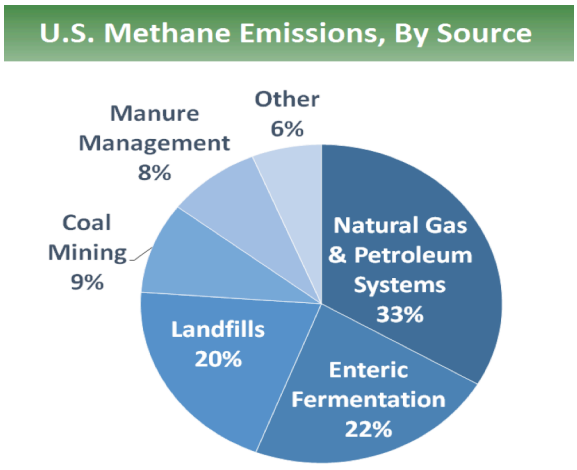
What Can and Should be Done

Our Governor Kate Brown is one signatory to the "Under 2 MOU," joining other responsible public authorities defending the Paris climate accords. http://under2mou.org/

Meanwhile those in possession of processes and controls on their corporate carbon properties are washing their hands of this crisis, banking bonuses, retirement accounts and dividends while sending the grief to hapless indigents least involved in causing the crisis.

To get started on doing something effective you would need to decide where the largest methane contributions are coming from: oil and gas production/distribution, agriculture, livestock, or landfills. This appears to be an open question, while our carbon budget dwindles.

https://www.scientificamerican.com/article/debate-rises-over-real-source-of-higher-methane-emissions/



Note: All emission estimates from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2014*.

Despite the clear evidence that CH4 is the most virulent threat in exceeding the 2 ^{0}C budget, there is no single authority established to impose adequate controls exclusively for all CH4 sources. If natural sources cannot be controlled in time, we must turn to controllable sources.

Once the will to control methane merges with authority and a policy mandate, why not task all the methane emitters to collectively decide amongst themselves …

1. Which source is most controllable?
2. Which source has the least civic consequence from cutting the source earliest?
3. How this can be executed by a time certain?
4. If you can't get the job done, say so.

The merit of this approach is that admitted polluters are in charge of containment, not government. But experimenting with this premise will surely exceed the disappearing chance to stop at 2 ^{0}C.

Above all else, no invoking the force majeure exemptions.
https://www.venable.com/understanding-force-majeure-clauses-2-25-2011/

What is Being Done Already

One of the most massive coal-fired power plants in the nation, the Navajo Station in Arizona, is closing soon. Cost of energy is the issue, not carbon fallout.
http://www.azcentral.com/story/money/business/energy/2017/02/13/utilities-vote-close-navajo-generating-station-coal-plant-2019/97866668/

This is a down payment on the "100 by 50" legislation: full reliance on 100% renewable energy supplies by 2050 (Thank You Senator Merkley). The effectiveness of this clean energy mandate depends on early containment of rogue methane, which all but nullifies the benefit of transitioning to clean energy if the 2 ^{0}C budget can't be managed in the meantime.

In California: "The Legislature has established that safety of the natural gas pipeline infrastructure in California is a priority for the Public Utilities Commission and gas corporations, and nothing in this article shall compromise or deprioritize safety as a top consideration." Ref SB 1371 (unfunded mandate).
http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB1371

The CA Air Resources Board has issued its Short Lived Climate Pollutant Strategy (March 2017)
https://www.arb.ca.gov/cc/shortlived/meetings/03142017/final_slcp_report.pdf
This report and its Appendices address all sources of methane (state inventory fractions noted):

Landfill	(20%)
Manure	(25%)
Dairy and non-dairy enteric fermentation	(30%)
Natural gas pipeline leaks, oil and gas extraction, wastewater, other industrial	(22%)

California's share of US CO2: 6.6%. Globally: 1%
Stated CA strategic methane reduction goals:

Reduce organics to landfill	75% below 2014 by 2025
Manure and enteric methane	40% below 2017 by 2030

Fugitive oil and gas	40% below 2017 by 2025
Fugitive oil and gas	45% below 2017 by 2030

Epilogue

Its possible to identify the annual rate at which the damage from the carbon giants must be curtailed. No one has yet deliberately voted to approve global self-destruction. The annual rate question is solved geometrically – any student of geometry can follow this.

In Figure E-1 the 2050 end date is shown with the midcourse transition point. This is chosen by simply recognizing that GHG reduction must start and end at certain times.

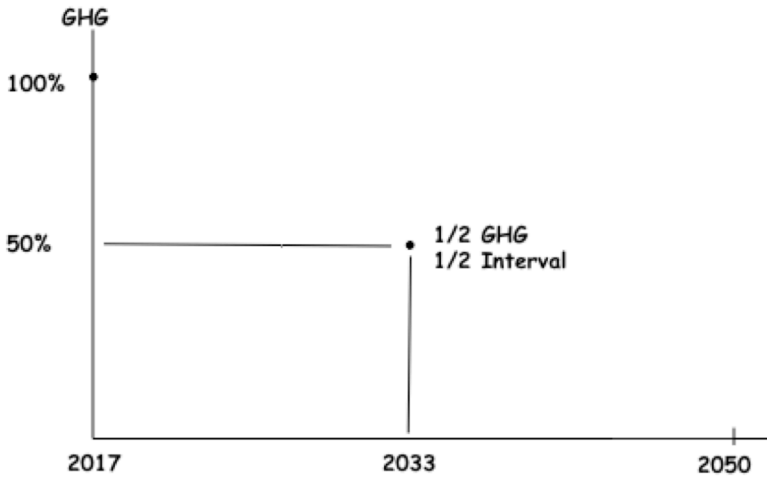


Figure E-1 Locate mid-course target

To pass through the midpoint, plot a path from 75% to 25% across 10 years. The result is 5% per year. Less that 5% per year will exceed the 2050 target.

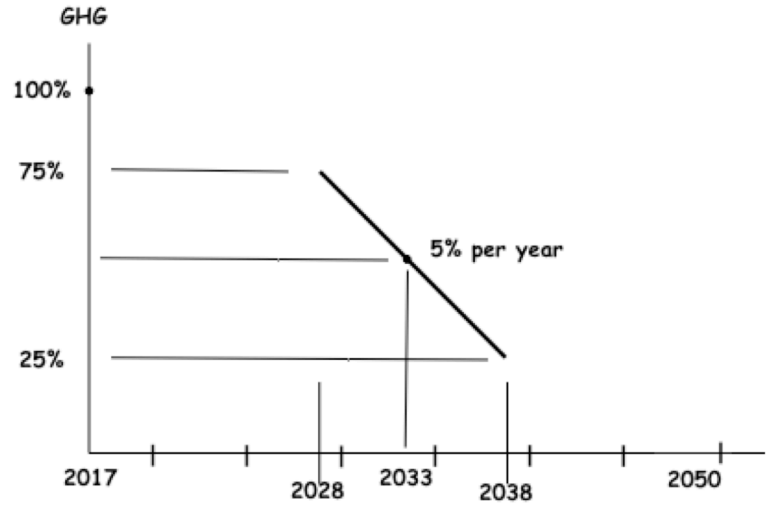


Figure E-2 Try for 50% reduction in 10 years

Navigating to the 5% per year interval will require careful planning that actually has not begun. In CA the Cap and Trade legislation has achieved an almost 10% reduction in GHG in 10 years, averaging 1% per year. "This represents an overall decrease of 9.4% since peak levels in 2004." https://www.arb.ca.gov/cc/inventory/pubs/reports/2000_2014/ghg_inventory_trends_00-14_20160617.pdf

Governor Kate Brown's Under 2 MOU commitment calls for GHG reduction to "80 to 95% below 1990 GHG levels by 2050." http://under2mou.org/wp-content/uploads/2015/04/Under2-MOU-English.pdf

Since the transition from the present day to an ambitious carbon reduction regime cannot be abrupt, Figure E-3 depicts the required planning phases.

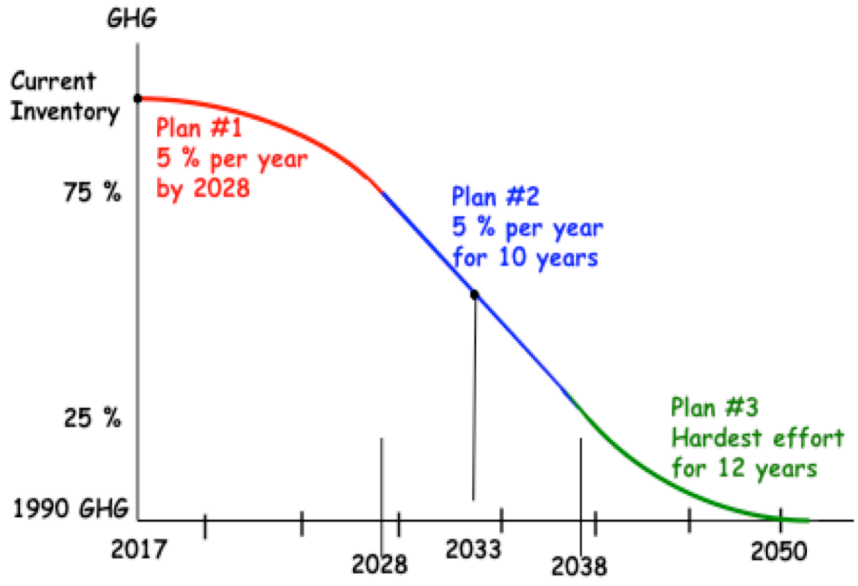


Figure E-3 A successful partnership of public and commercial sectors

Step 1 is easy. Replace extractive greed with a survival plan for humanity.

Beware of solutions that arrive too late, like industrial carbon sequestration, or that involve solving risk by adding more risk, like earth-scale geo-engineering. First, ask who made this dilemma SO INESCAPABLY NECESSARY, and stop offering any deference to the planet's many antagonists.

With climate planning, peace negotiators should necessarily prevail. Reverting to heroic military means can actually defeat the pollution reductions needed to attain critical goals before reaching any of the catastrophic tipping points. "Safe" wars that nature can absorb and recover from could be a thing of the past.