UPDATED SUBMISSION TO LOW EMISSION ECONOMY INQUIRY

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The actual half- life of methane measured over the last 30 years can be calculated as 6.21 years using the known annual global atmospheric loads and the well-researched estimates of global methane emissions. From this the GWP can be calculated as 5.5

IPCC 2001 report postulated and imposed a number of adjustments, the first three relating to the effective half-life of methane, namely a perturbation adjustment (40%), an e-fold adjustment (23.6%) and an OH depletion adjustment (40%). This brought the supposed half-life up to 17 years and the GWP to 15.8. It is evident from the measured actual half-life that none of the postulated adjustments have become reality and should be negated.

Additionally, in 2001, 2004 and 2017 IPCC have made further upward adjustments of the GWP relating to O2, Ozone and water effects. All these are all predicated on the "extra" methane that the supposed longer half-life would have caused. The half-life has not extended as postulated, hence all these adjustments also need to be negated.

There is some discussion on the effect of breakdown products, CO2 and H20. In the atmosphere Methane is measure in parts for billion, CO2 in parts per thousand and water vapour in parts per hundred. The breakdown components of methane are trivial.

The GWP of methane should be 5.5 not 28.

Attachments

1. Derivation of the half-life of methane
2. Derivation of GWP of Methane

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Derivation of Half Life of Methane

The global atmospheric load of methane is well understood and annual concentrations are available in parts per billion over the last 30 years and more. These can be converted from parts per billion (ppb) to Giga Tonnes (Gt) of methane using the factor 2.78.

Annual Methane emissions have been well researched and over the last 30 years are estimated at 550 Gt plus or minus 50 Gt.

Using excel the standard half-life series can be produce with.

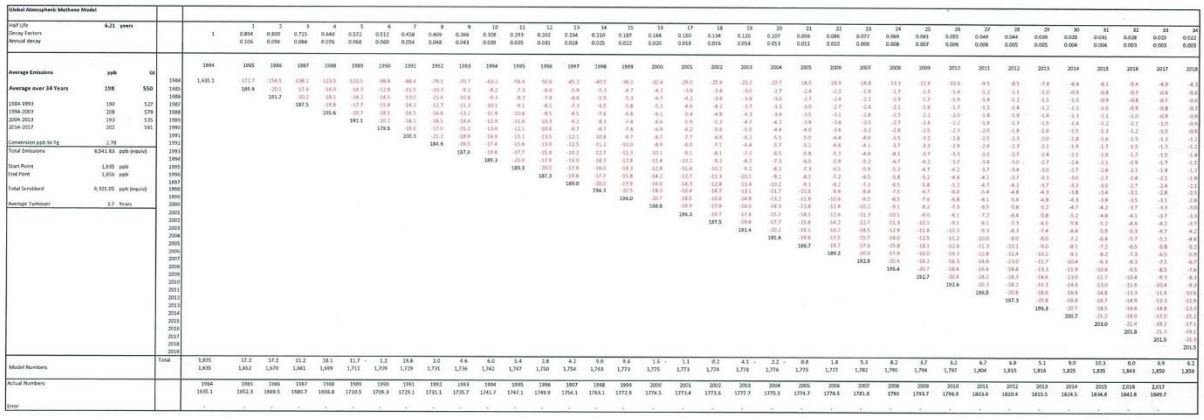
= EXP (-LN(2)*A/B) where A is the year number and B is the half-Life

An algorithm can be created with the following inputs (suggest using ppb).

- The initial concentration
- The annual year one loss using the half-life formula (using any provisional half-life number)
- The increase/decrease in year one atmospheric concentration

The result gives the year one global emissions. The process can then be repeat over 30 years to produce a series of global emissions. Calculate the annual average emissions and convert to Gt

By manipulating the half-life until the average global emissions match 550 Gt the half-life of methane can be derived as 6.21 years



Global Atmospheric Methane Model		
Half Life	6.21	years
Decay Factors		
Annual decay		
Average Emissions	ppb	Gt
Average over 34 Years	198	550
1984-1993	190	527
1994-2003	208	579
2004-2013	193	535
2014-2017	202	561
Conversion ppb to Tg	2.78	
Total Emissions	6,541.83	ppb (equiv)
Start Point	1,635	ppb
End Point	1,856	ppb
Total Scrubbed	6,325.05	ppb (equiv)
Average Turnover	3.7	Years

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Decay Factors	1	0.894	0.800	0.715	0.640	0.572	0.512	0.458	0.409	0.366	0.328	0.293	0.262	0.234	0.210	0.187	0.168	0.150	0.134	0.120	0.107	0.096	0.086	0.077	0.069	0.061	0.055	0.049	0.044	0.039	0.035	0.031	0.028	0.022
Annual decay		0.106	0.094	0.084	0.076	0.068	0.060	0.054	0.048	0.043	0.039	0.035	0.031	0.028	0.025	0.022	0.020	0.018	0.016	0.014	0.013	0.011	0.010	0.009	0.008	0.007	0.006	0.006	0.005	0.005	0.004	0.004	0.003	0.003	0.003

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1984	1,635.1	-172.7	-154.5	-138.1	-123.5	-110.5	-98.8	-88.4	-79.1	-70.7	-63.2	-56.6	-50.6	-45.2	-40.5	-36.2	-32.4	-29.0	-25.9	-23.1	-20.7	-18.5	-16.6	-14.8	-13.3	-11.9	-10.6	-9.5	-8.5	-7.6	-6.8	-6.1	-5.4	-4.9	-4.3
1985		189.9	-20.1	-17.9	-16.0	-14.3	-12.8	-11.5	-10.3	-9.2	-8.2	-7.3	-6.6	-5.9	-5.3	-4.7	-4.2	-3.8	-3.4	-3.0	-2.7	-2.4	-2.1	-1.9	-1.7	-1.5	-1.4	-1.2	-1.1	-1.0	-0.9	-0.8	-0.7	-0.6	-0.6
1986			191.7	-20.2	-18.1	-16.2	-14.5	-13.0	-11.6	-10.4	-9.3	-8.3	-7.4	-6.6	-5.9	-5.3	-4.7	-4.2	-3.8	-3.4	-3.0	-2.7	-2.4	-2.2	-1.9	-1.7	-1.5	-1.4	-1.2	-1.1	-1.0	-0.9	-0.8	-0.7	-0.6
1987				187.5	-19.8	-17.7	-15.9	-14.2	-12.7	-11.3	-10.1	-9.1	-8.1	-7.3	-6.5	-5.8	-5.2	-4.6	-4.2	-3.7	-3.3	-3.0	-2.7	-2.4	-2.1	-1.9	-1.7	-1.5	-1.4	-1.2	-1.1	-1.0	-0.9	-0.8	-0.7
1988					195.6	-20.7	-18.5	-16.5	-14.8	-13.2	-11.8	-10.6	-9.5	-8.5	-7.6	-6.8	-6.1	-5.4	-4.8	-4.3	-3.9	-3.5	-3.1	-2.8	-2.5	-2.2	-2.0	-1.8	-1.6	-1.4	-1.3	-1.1	-1.0	-0.9	-0.8	-0.8
1989						191.1	-20.2	-18.1	-16.1	-14.4	-12.9	-11.6	-10.3	-9.3	-8.3	-7.4	-6.6	-5.9	-5.3	-4.7	-4.2	-3.8	-3.4	-3.0	-2.7	-2.4	-2.2	-1.9	-1.7	-1.5	-1.4	-1.2	-1.1	-1.0	-0.9	-0.8
1990							179.3	-19.0	-17.0	-15.2	-13.6	-12.1	-10.8	-9.7	-8.7	-7.8	-6.9	-6.2	-5.6	-5.0	-4.4	-4.0	-3.6	-3.2	-2.8	-2.5	-2.2	-2.0	-1.8	-1.6	-1.5	-1.3	-1.2	-1.0	-0.9
1991								200.3	-17.2	-15.4	-13.8	-12.3	-11.0	-9.8	-8.7	-7.8	-7.0	-6.3	-5.7	-5.1	-4.5	-4.0	-3.6	-3.2	-2.9	-2.6	-2.3	-2.0	-1.8	-1.6	-1.5	-1.3	-1.2	-1.0	-0.9
1992									184.4	-18.9	-16.9	-15.1	-13.5	-12.1	-10.8	-9.7	-8.7	-7.7	-6.9	-6.2	-5.5	-5.0	-4.4	-4.0	-3.5	-3.2	-2.8	-2.5	-2.3	-2.0	-1.8	-1.6	-1.5	-1.3	-1.2
1993										187.4	-19.8	-17.4	-15.6	-13.9	-12.5	-11.2	-10.0	-8.9	-8.0	-7.1	-6.4	-5.7	-5.1	-4.6	-4.1	-3.7	-3.3	-2.9	-2.6	-2.3	-2.1	-1.9	-1.7	-1.5	-1.3
1994											189.3	-17.7	-15.8	-14.2	-12.7	-11.3	-10.1	-9.1	-8.1	-7.2	-6.5	-5.8	-5.2	-4.6	-4.1	-3.7	-3.3	-3.0	-2.7	-2.4	-2.1	-1.9	-1.7	-1.5	-1.4
1995												189.3	-20.0	-17.9	-16.0	-14.3	-12.8	-11.4	-10.2	-9.2	-8.2	-7.3	-6.5	-5.9	-5.2	-4.7	-4.2	-3.7	-3.4	-3.0	-2.7	-2.4	-2.1	-1.9	-1.7
1996													187.3	-19.9	-17.7	-15.8	-14.2	-12.7	-11.3	-10.1	-9.1	-8.1	-7.2	-6.5	-5.8	-5.2	-4.6	-4.1	-3.7	-3.3	-3.0	-2.7	-2.4	-2.1	-1.9
1997														189.0	-20.0	-17.9	-16.0	-14.3	-12.8	-11.4	-10.2	-9.1	-8.2	-7.3	-6.5	-5.8	-5.2	-4.7	-4.2	-3.7	-3.3	-3.0	-2.7	-2.4	-2.1
1998															196.5	-20.9	-18.5	-16.6	-14.8	-13.2	-11.8	-10.6	-9.4	-8.4	-7.5	-6.7	-6.0	-5.4	-4.8	-4.3	-3.8	-3.4	-3.1	-2.8	-2.5
1999																194.0	-20.7	-18.5	-16.6	-14.8	-13.2	-11.8	-10.6	-9.5	-8.5	-7.6	-6.8	-6.1	-5.4	-4.9	-4.3	-3.9	-3.5	-3.1	-2.8	-2.6
2000																	188.8	-19.9	-17.8	-16.0	-14.3	-12.8	-11.4	-10.2	-9.1	-8.2	-7.3	-6.5	-5.8	-5.2	-4.7	-4.2	-3.7	-3.3	-3.0
2001																		196.3	-19.7	-17.6	-15.7	-14.1	-12.7	-11.4	-10.2	-9.1	-8.2	-7.3	-6.5	-5.8	-5.2	-4.6	-4.1	-3.7	-3.3
2002																			187.5	-19.8	-17.7	-15.8	-14.2	-12.7	-11.3	-10.1	-9.1	-8.1	-7.2	-6.4	-5.8	-5.2	-4.6	-4.2	-3.7
2003																				191.4	-20.2	-18.1	-16.2	-14.5	-12.9	-11.6	-10.3	-9.3	-8.3	-7.4	-6.6	-5.9	-5.3	-4.7	-4.2
2004																					185.6	-19.6	-17.5	-15.7	-14.0	-12.5	-11.2	-10.0	-9.0	-8.0	-7.2	-6.4	-5.7	-5.1	-4.6
2005																						188.7	-19.7	-17.6	-15.8	-14.1	-12.6	-11.3	-10.1	-9.0	-8.1	-7.2	-6.5	-5.8	-5.2
2006																							189.2	-19.6	-17.5	-15.7	-14.0	-12.5	-11.2	-10.0	-9.0	-8.1	-7.2	-6.4	-5.7
2007																								192.9	-20.4	-18.2	-16.3	-14.6	-13.0	-11.7	-10.5	-9.4	-8.4	-7.5	-6.7
2008																									196.4	-20.7	-18.6	-16.6	-14.8	-13.3	-11.9	-10.6	-9.5	-8.5	-7.6
2009																										192.7	-20.4	-18.2	-16.3	-14.6	-13.0	-11.7	-10.4	-9.3	-8.3
2010																											192.6	-20.3	-18.2	-16.3	-14.6	-13.0	-11.6	-10.4	-9.3
2011																												196.5	-20.6	-18.5	-16.6	-14.8	-13.3	-11.9	-10.6
2012																													197.3	-20.8	-18.6	-16.7	-14.9	-13.3	-11.9
2013																														196.3	-20.7	-18.5	-16.6	-14.8	-13.3
2014																															200.7	-21.2	-18.9	-17.0	-15.2
2015																																203.0	-21.4	-19.2	-17.1
2016																																	201.8	-21.3	-19.1
2017																																		201.5	-21.3
2018																																			201.5
Total	1,635	17.2	17.2	11.2	18.1	11.7	-1.2	19.8	2.0	4.9	6.0	5.4	2.8	4.2	6.0	9.8	1.6	1.1	0.2	4.1	2.2	0.8	1.8	5.3	8.2	3.7	3.2	6.7	6.8	5.1	9.0	10.3	8.0	6.9	6.2
Model Numbers	1,635	1,652	1,670	1,681	1,699	1,711	1,709	1,729	1,731	1,736	1,742	1,747	1,750	1,754	1,763	1,773	1,775	1,773	1,774	1,778	1,776	1,775	1,777	1,782	1,790	1,794	1,797	1,804	1,810	1,816	1,825	1,835	1,843	1,850	1,856
Actual Numbers		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
		1635.1	1652.3	1669.5	1680.7	1698.8	1710.5	1709.3	1728.1	1731.1	1735.7	1741.7	1742.1	1749.9	1754.1	1763.1	1772.9	1774.5	1773.4	1773.6	1777.7	1775.5	1774.7	1776.5	1781.8	1790	1793.7	1796.9	1803.6	1810.4	1815.5	1824.5	1834.8	1842.8	1849.7	
Error		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

(For Excel spreadsheet text a request and provide email address to 021 417 426.)

Derivation of GWP of Methane

IPCC in 2001 defined GWP as.

$$GWP(x) = \frac{\int_0^{TH} a_x \bullet [x(t)]\, dt}{\int_0^{TH} a_r \bullet [r(t)]\, dt} \qquad (6.2)$$

where TH is the time horizon over which the calculation is considered, a_x is the radiative efficiency due to a unit increase in atmospheric abundance of the substance in question (i.e., $Wm^{-2}\ kg^{-1}$), [x(t)] is the time-dependent decay in abundance of the instantaneous release of the substance, and the corresponding quantities for the reference gas are in the denominator. The GWP

This can be presented in excel form as:

$$GWP = \frac{\text{Mol Mass CO2}}{\text{Mol Mass CH4}} \times \frac{\text{RE CH4}}{\text{RE CO2}} \times \frac{\text{-A*(EXP (-B/A)-1)}}{\text{-C*(EXP (-B/C)-1)}}$$

A Half-life CH4 (6.21yr) B is Time Horizon (100yr) C Half-life of CO2 (150yr)

$$GWP = \frac{44}{16} \times \frac{.37}{.01584} \times \frac{6.21}{72.99} = 5.5$$

IPCC PULSE MODEL

GWP(mass) for Methane 100 years *note 1*

	Molecular Mass CO2	44
	Molecular Mass CH4	16
A	AM CO2/AM CH4	2.75
	Radiative Efficiency CO2	0.01584
	Radiative Efficiency CH4	0.37
B	RE CH4/RE CO2	23.36
	Lifetime of C02 (yrs)	150
	Time Horizon (yrs)	100
C	Decay Function CO2	72.99 yrs
	Lifetime of CH4 (yrs)	12.83
	Time Horizon (yrs)	100
D	Decay Function CH4	12.82 yrs
GWP	A*B*D/ C	11.3

Notes	GWP Adjustments	Additions	Yrs	GWP
2	Burden Lifetime (half life)		7.25	
3	Pulse Lifetime (half life)	40%	10.15	
4	Pulse Lifetime (e fold)	26.4%	12.83	11.3
5	Pulse Adjustment for OH depletion	40%	18.00	15.8
6	Pulse Adjustment for O3 increase	40%		22.1
7	Pulse Adjustment for Stratospheric H20	4%		23.0
8	Pulse Adjustment for Stratospheric H20	9%		25.1
			GWP (mass)	25.0

Sources & references

1 *Model adapted from Mathew J Elrod, Dept Chem Hope College MI*
2 *EPA quoted various sources as 7 years*
3 *IPCC/TEAC Special report 2005 page 140*
4 *ibid*
5 *IPCC Tar/Wg1 TAR 6 page 365*
6 *ibid*
7 *ibid*

Highlights indicate interconnections

STEADY STATE MODEL - IPCC adjustments removed

GWP(mass) for Methane 100 years *note 1*

	Molecular Mass CO2	44
	Molecular Mass CH4	16
A	AM CO2/AM CH4	2.75
	Radiative Efficiency CO2	0.01584
	Radiative Efficiency CH4	0.37
B	RE CH4/RE CO2	23.36
	Lifetime of C02 (yrs)	150
	Time Horizon (yrs)	100
C	Decay Function CO2	72.99 yrs
	Lifetime of CH4 (yrs)	6.21
	Time Horizon (yrs)	100
D	Decay Function CH4	6.21 yrs
GWP	A*B*D/ C	5.5

Notes	GWP Adjustments	Additions	Yrs	GWP
2	Burden Lifetime (half life)		7.25	
3	Pulse Lifetime (half life)	0%	7.25	
4	Pulse Lifetime (e fold)	0.0%	7.25	5.5
5	Pulse Adjustment for OH depletion	0%		5.5
6	Pulse Adjustment for O3 increase	0%		5.5
7	Pulse Adjustment for Stratospheric H20	0%		5.5
			GWP (mass)	5.5

Sources & references

1 *Model adapted from Mathew J Elrod, Dept Chem Hope College MI*
2 *EPA quoted various sources as 7 years*
3 *IPCC/TEAC Special report 2005 page 140*
4 *ibid*
5 *IPCC Tar/Wg1 TAR 6 page 365*
6 *ibid*
7 *ibid*

Highlights indicate interconnections

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