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Fair Plan 10: Post-Trump Global-Warming Mitigation

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Abstract

With the election of Donald Trump as President of the United States of America, it appears likely that the initiation of mitigation of human-caused Global-Warming/Climate-Change will be delayed many years. Accordingly, here we calculate the Emission Phaseout Duration, $D = Y_E - Y_S$, where Y_S and Y_E are the Start and End Years of the emissions reduction, for Y_S = 2020, 2025 and 2030, and maximum Global Warming targets, ΔT_{max} = 2.0˚C, 1.9˚C, 1.8˚C, 1.7˚C, 1.6˚C and 1.5˚C. The 2.0˚C and 1.5˚C maxima are the "Hard" and "Aspirational" targets of the 2015 Paris Climate Agreement. We find that D decreases with increasing Y_S from 2020, and with decreasing ΔT_{max}. In particular, D decreases from: 1) 76 years for Y_S = 2020 to 53 years for Y_S = 2030 for ΔT_{max} = 2.0˚C, and 2) 34 years for Y_S = 2020 to 7 years for Y_S = 2030 for ΔT_{max} = 1.5˚C. Thus, delaying the initiation of the phaseout of greenhouse-gas emissions from 2020 to 2030 makes it more difficult to achieve ΔT_{max} = 2.0˚C and impossible to achieve ΔT_{max} = 1.5˚C.

Keywords

Climate Change, Fair Plan, Trump, Mitigation

1. Introduction

On 28 March 2017, the Trump Administration declared war on: 1) Climate Science, 2) Climate Scientists, 3) the Obama Administration's program to mitigate Human-Caused Global Warming/Climate Change = the Clean Power Plan, and 4) humanity's preventing further Human-Caused Global Warming/Climate Change [1].

On 1 June 2017, the Trump Administration performed a likely coup de gras to the 2015 Paris Climate Agreement by signaled its intention to withdraw therefrom [2].

In the course of human events, these declarations of war are faux pas of the gravest magnitude.

Herein we explicate why this is so, and we chart a future, post-Trump course of greenhouse-gas emissions reduction to reverse it.

Herein we shall answer the question:

How many years before 2100 do we need to zero the emission of greenhouse gases for every year post 2020 we delay initiating the reduction of greenhouse-gas emissions in order to keep global warming below:

1) the 2˚C maximum Global Warming adopted by the UN Framework Convention on Climate Change (UNFCCC) in 2010 at the Conference of the Parties 16 (COP16) in Cancun, Mexico, "to prevent dangerous anthropogenic interference with the climate system" of [3] = the "hard" target of the 2015 Paris Climate Agreement [4], and

2) the 1.5˚C maximum warming adopted by the UN Framework Convention on Climate Change (UNFCCC) in 2015 at the Conference of the Parties 21 (COP21) in Paris, France, = the "aspirational" target of the 2015 Paris Climate Agreement [4]?

2. Reference Emission Scenario

As our Reference emission scenario, we take the RCP-8.5 emission scenario [5] developed by the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria, as one of the four emission scenarios for the fifth assessment report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) [6]. RCP-8.5 is the highest of these four emission scenarios and leads to a radiative forcing (the change in the net incoming radiation at the top of the atmosphere) of about 8.5 Wm^{-2} in 2100. For comparison, a doubling of the preindustrial carbon dioxide (CO_2) concentration causes a radiative forcing of 3.7 Wm^{-2}. RCP-8.5 is the way the world would likely emit greenhouse gases if either there were no consequent climate change or if we were completely ignorant of the climate change.

The Reference scenario contains annual emission rates for CO_2 and 31 additional greenhouse gases (CH_4, N_2O, CFC11, CFC12, CFC113, CFC114, CFC115, CCl4, CH3CCl3, HCFC22, HCFC141b, HCFC123, HCFC124, HCFC142b, HCFC225ca, HCFC225cb, HCFC134a, HCFC125, HCFC152a, CF4, C2F6, SF6, H1211, H1301, H2402, CH3Br, HFC23, HFC143a, HFC32, HFC227, HFC245, C6F14, tropospheric O_3). It also contains the annual emission rates for three aerosol/precursors (SO_2, black carbon, organic carbon). The RCP-8.5 scenario begins in 2000. Before 2000, RCP-8.5 emission rates are the historical emission rates.

The CO_2 emission rate for the Reference scenario is shown in Figure 1 for the 21st century alone, the time period of interest herein. The CO_2 emission rate rises from about 29 billion tonnes of carbon dioxide per year (Gt CO_2/year) in 2000 to 106 Gt CO_2/year in 2100, a factor of 3.7 increase across the century.

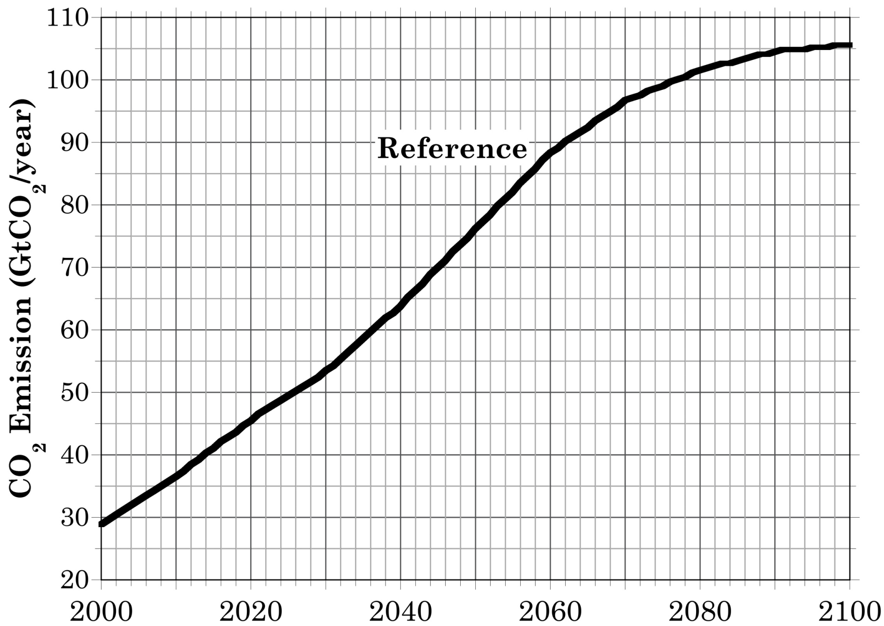

Figure 1. Annual CO_2 emission rate [Gigatonnes of CO_2 per year ($GtCO_2$/year)] versus year in the 21st century for the Reference (RCP-8.5) scenario.

3. Reduced-Emission Scenarios

We define our reduced-emission scenarios for each of the above species by

$$E_{Red}\left(y;Y_S,Y_E\right)=I\left(y;Y_S,Y_E\right)\cdot E_{Ref}\left(y\right) \tag{1}$$

where

$$I\left(y;Y_S,Y_E\right)=\begin{cases}1, & y\le Y_S\\ 1-\left(y-Y_S\right)/\left(Y_E-Y_S\right), & Y_S\le y\le Y_E\\ 0, & y\ge Y_E\end{cases} \tag{2}$$

is emission intensity in year y for Start Year, Y_S, and End Year, Y_E.

It should be noted that these linear-in-time emission intensities are applied to the global emissions, not just to the emissions of the Developed Countries, as in our 10 antecedent Fair Plan papers [7]-[16]. In those papers, the emission intensities for the Developing Countries were larger in the beginning years, and smaller in the later years than the linear intensities, this so that:

1) the total cumulative traded-adjusted CO_2 emissions of the Developing Countries equaled the total trade-adjusted CO_2 emissions of the Developed Countries—the first Fairness, where trade-adjusted emissions are the CO_2 emissions generated by the Developing Countries in the production of goods and services for the Developed Countries, which emissions are debited to the Developed Countries, not the Developing Countries—the second Fairness; and

2) the maximum global-mean near-surface air temperature was kept below the 2˚C limit adopted by the UN Framework Convention on Climate Change "to prevent dangerous anthropogenic interference with the climate system" [3].

Figure 2 presents the emissions intensity $I\left(y;Y_S,Y_E\right)$ versus year in the 21st century for Y_S = 2020, 2025 and 2030, and Y_E = 2100, 2090, 2080, 2070, 2060,

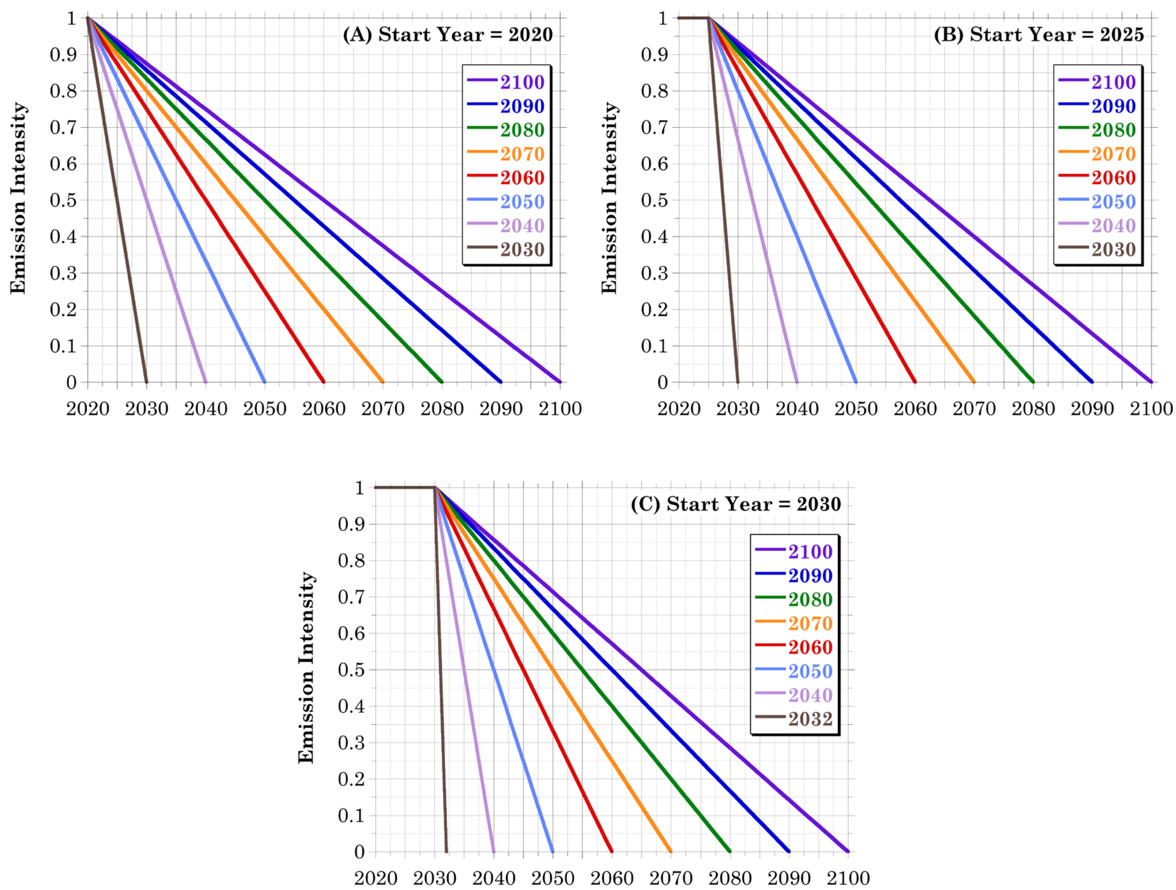

Figure 2. Emissions intensity versus year in the 21st century for Start Years Y_s = 2020, 2025 and 2030 for End Years Y_E = 2100, 2090, 2080, 2070, 2060, 2050, 2040, 2030 (2032 for Y_S = 2030).

2050, 2040, 2030 (2032 for Y_S = 2030). The resulting reduced annual emission rates $E_{Red}\left(y;Y_S,Y_E\right)$ for CO_2 from Equation (1) are shown in Figure 3 versus year in the 21st century for Start Years Y_S = 2020, 2025 and 2030, and End Years Y_E = 2100, 2090, 2080, 2070, 2060, 2050, 2040, 2030 (2032 for Y_S = 2030), together with the Reference annual emission rate for CO_2, $E_{Ref}\left(y\right)$. For $Y_E \leq$ 2080, the annual CO_2 emission rates monotonically decrease from $y \geq Y_S$ to zero in Y_E. For Y_E = 2090 and 2100, the initial annual CO_2 emission rates are respectively flat and slightly increasing before they too decrease to zero in Y_E.

4. Species Concentrations and Total Radiative Forcing

We have used the model of the Center for International Climate and Environmental Research-Oslo (CICERO) [17] to calculate the species concentrations from their emissions.

It should be noted that the CICERO model does not include the positive ocean-CO_2-solubility/temperature feedback whereby the fraction of emitted CO_2 removed from the atmosphere by the ocean decreases with increasing temperature. Thus, *ceteris paribus*, our calculated CO_2 concentrations are underestimates

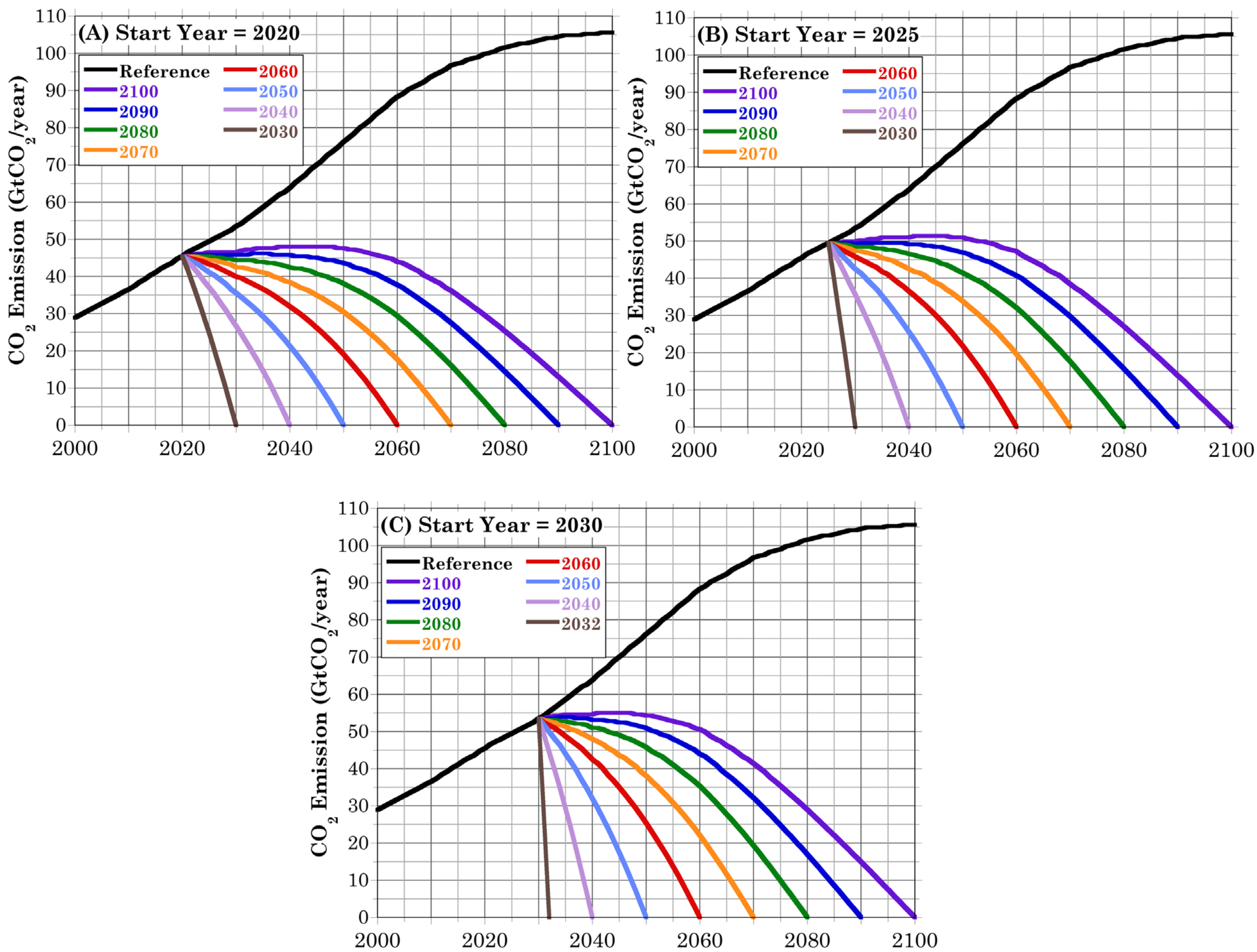

Figure 3. Reduced annual CO_2 emission rate scenarios [Gigatonnes of CO_2 per year (GtCO2/year)] versus year in the 21st century for Start Years Y_S = 2020, 2025 and 2030, and End Years Y_E = 2100, 2090, 2080, 2070, 2060, 2050, 2040, 2030 (2032 for Y_S = 2030).

of those with this positive feedback included.

Figure 4 presents the CO_2 concentrations versus year in the 21st century for the Reference scenario and for the Reduced-emissions scenarios, the latter for Start Years Y_S = 2020, 2025 and 2030, and End Years Y_E = 2100, 2090, 2080, 2070, 2060, 2050, 2040, 2030 (2032 for Y_S = 2030).

The CO_2 concentration for the Reference scenario monotonically increases across the 21st century, from 372 ppmv in 2000 to 903 ppmv in 2100, exceeding twice the pre-industrial concentration of 278 ppmv in 2053.

The CO_2 concentrations for the Reduced-emissions scenarios peak within the 21st century, with the peak occurring later and being larger the later the Start Year, Y_S, and for each Y_S, occurring sooner and being smaller the earlier the End Year, Y_E. The peak CO_2 concentrations exceed twice the pre-industrial CO_2 concentration for all Y_S, for both Y_E = 2100 and 2090 for Y_S = 2030, but only for Y_E = 2100 for Y_S = 2020 and 2025.

Figure 5 presents the total radiative forcing relative to 1750 [Watts per square meter (Wm^{-2})] versus year in the 21st century for the Reference scenario and for the Reduced-emissions scenarios, the latter for Start Years Y_S = 2020, 2025 and

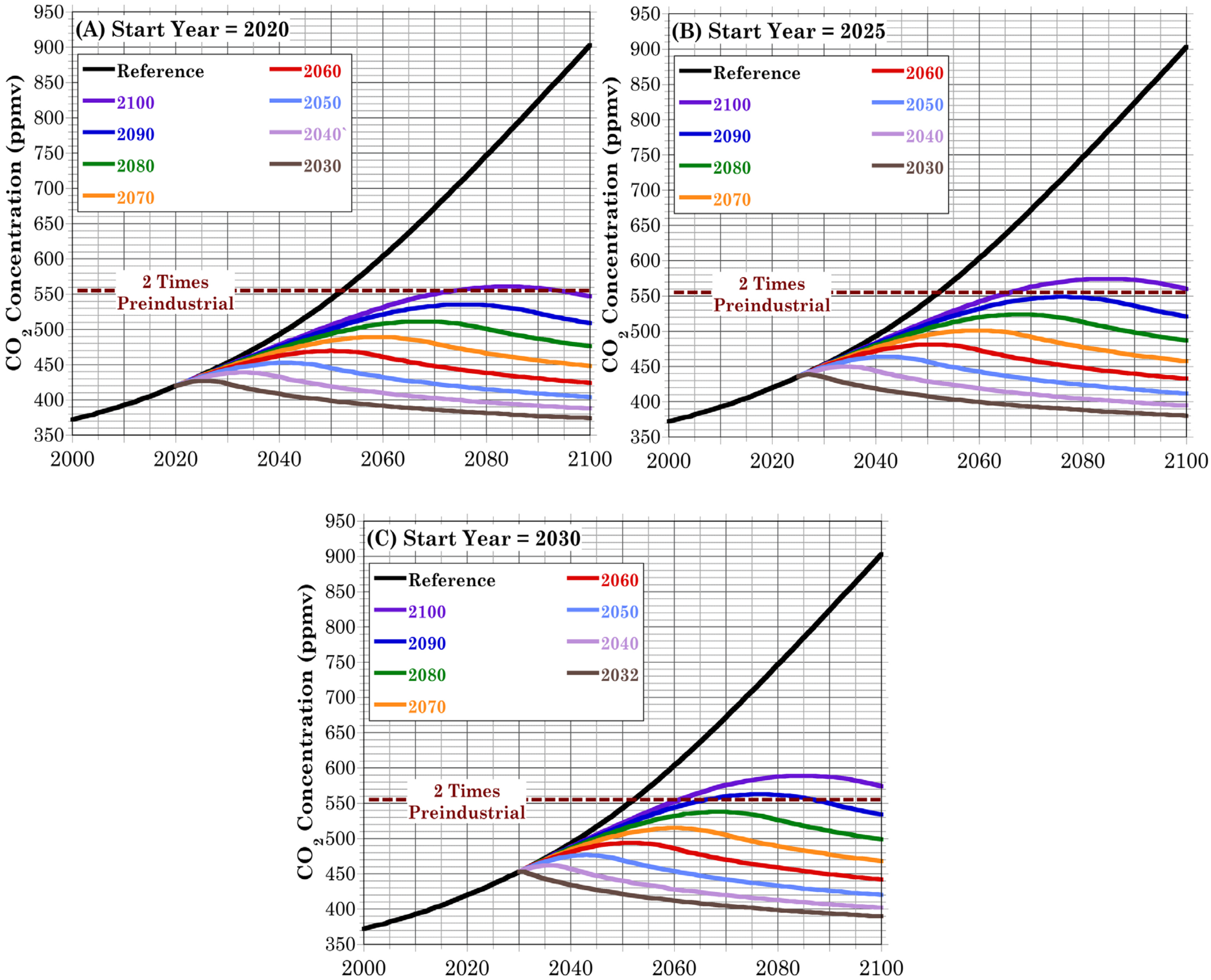

Figure 4. CO_2 concentration [parts per million by volume (ppmv)] versus year in the 21st century for Start Years Y_S = 2020, 2025 and 2030, and End Years Y_E = 2100, 2090, 2080, 2070, 2060, 2050, 2040, 2030 (2032 for Y_S = 2030).

2030, and End Years Y_E = 2100, 2090, 2080, 2070, 2060, 2050, 2040, 2030 (2032 for Y_S = 2030).

The total radiative forcing relative to 1750 for the Reference scenario increases monotonically across the 21st century, from 2.19 Wm^{-2} in 2000 to 8.67 Wm^{-2} in 2100, exceeding the total radiative forcing for twice the pre-industrial CO_2 concentration of 3.71 Wm^{-2} in 2031. This is 22 years earlier than the year when the CO_2 concentration first exceeds twice the preindustrial CO_2 concentration. This is due to the radiative forcing by the other, non-CO_2, greenhouse gases listed in Section 2.

The total radiative forcing relative to 1750 for the Reduced-emissions scenarios peak within the 21st century, with the peak occurring later and being larger the later the Start Year, Y_S, and for each Y_S, occurring sooner and being smaller the earlier the End Year, Y_E. The peak total radiative forcings exceed twice the radiative forcing for twice the pre-industrial CO_2 concentration for all Y_S, for $Y_E \geq$ 2070, 2060 and 2040 for Y_S = 2020, 2025 and 2030, respectively.

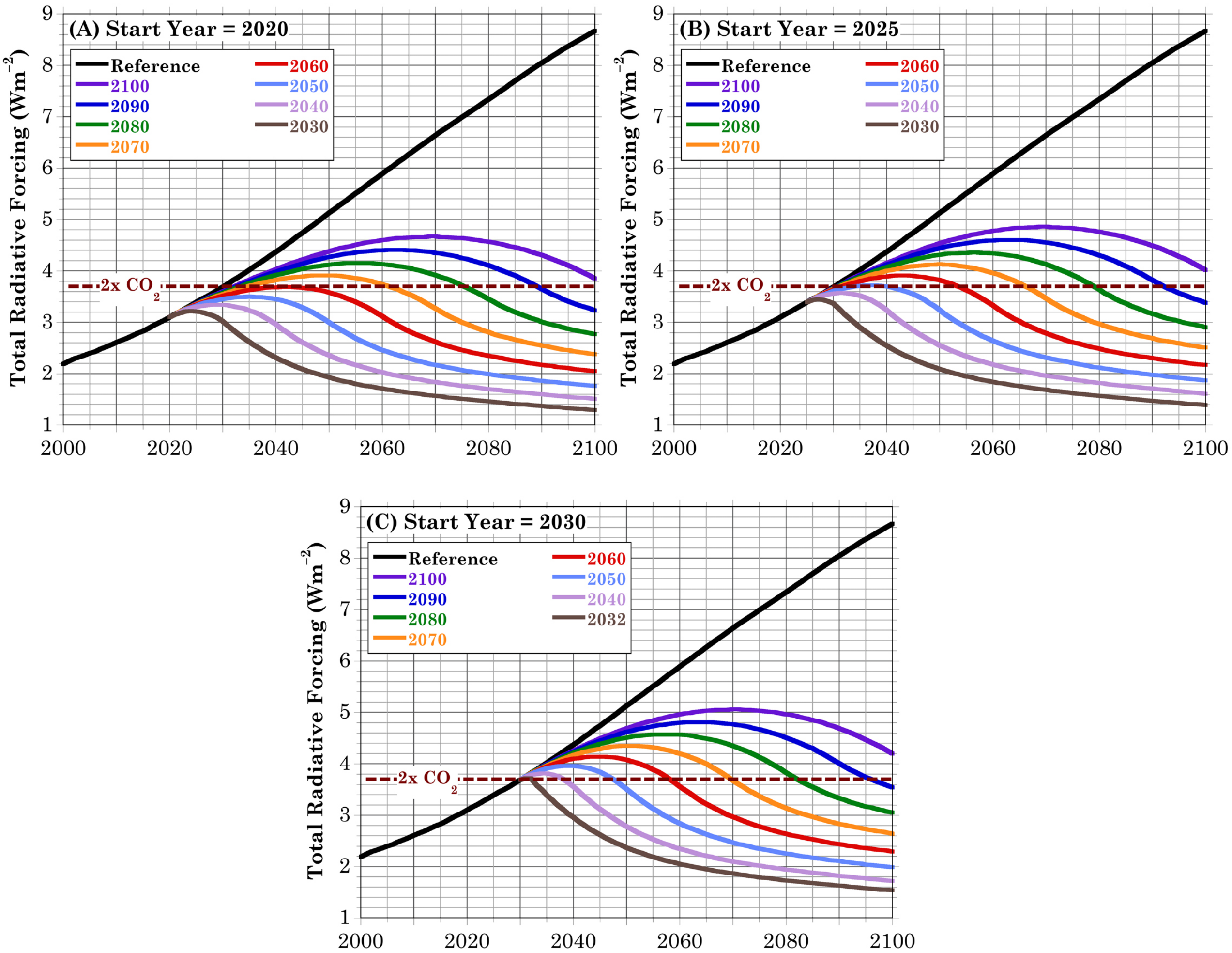

Figure 5. Total radiative forcing relative to 1750 [Watts per square meter (Wm^{-2})] versus year in the 21st century for Start Years Y_S = 2020, 2025 and 2030, and End Years Y_E = 2100, 2090, 2080, 2070, 2060, 2050, 2040, 2030 (2032 for Y_S = 2030).

5. Global Warming

As we have in our 10 antecedent Fair Plan papers [7] [8] [9] [10] [11] [13] [14] [15] [16], we have used our engineering-type simple climate model [18] to calculate the change in global-mean near-surface air temperature relative to 1750, now for the total radiative forcing shown in Figure 5. In our 10 earlier Fair Plan papers, we performed calculations of Global Warming for the equilibrium climate sensitivity (ΔT_{2x}, the change in global-mean near-surface air temperature from 1750 due to the radiative forcing caused by an instantaneous doubling of the preindustrial CO_2 concentration) estimated by us from the four observed temperature datasets in our 2012 Causes paper [19] (1.45˚C, 1.61˚C, 1.99˚C and 2.01˚C), and then averaged them. Here, we performed calculations of Global Warming for $\Delta T_{2x} = 2.0$˚C.

Figure 6 presents the change in global-mean near-surface air temperature relative to 1750 [Global Warming, degrees Celsius (˚C)] versus year in the 21st century for Start Years Y_S = 2020, 2025 and 2030, and End Years Y_E = 2100, 2090, 2080, 2070, 2060, 2050, 2040, 2030 (2032 for Y_S = 2030).

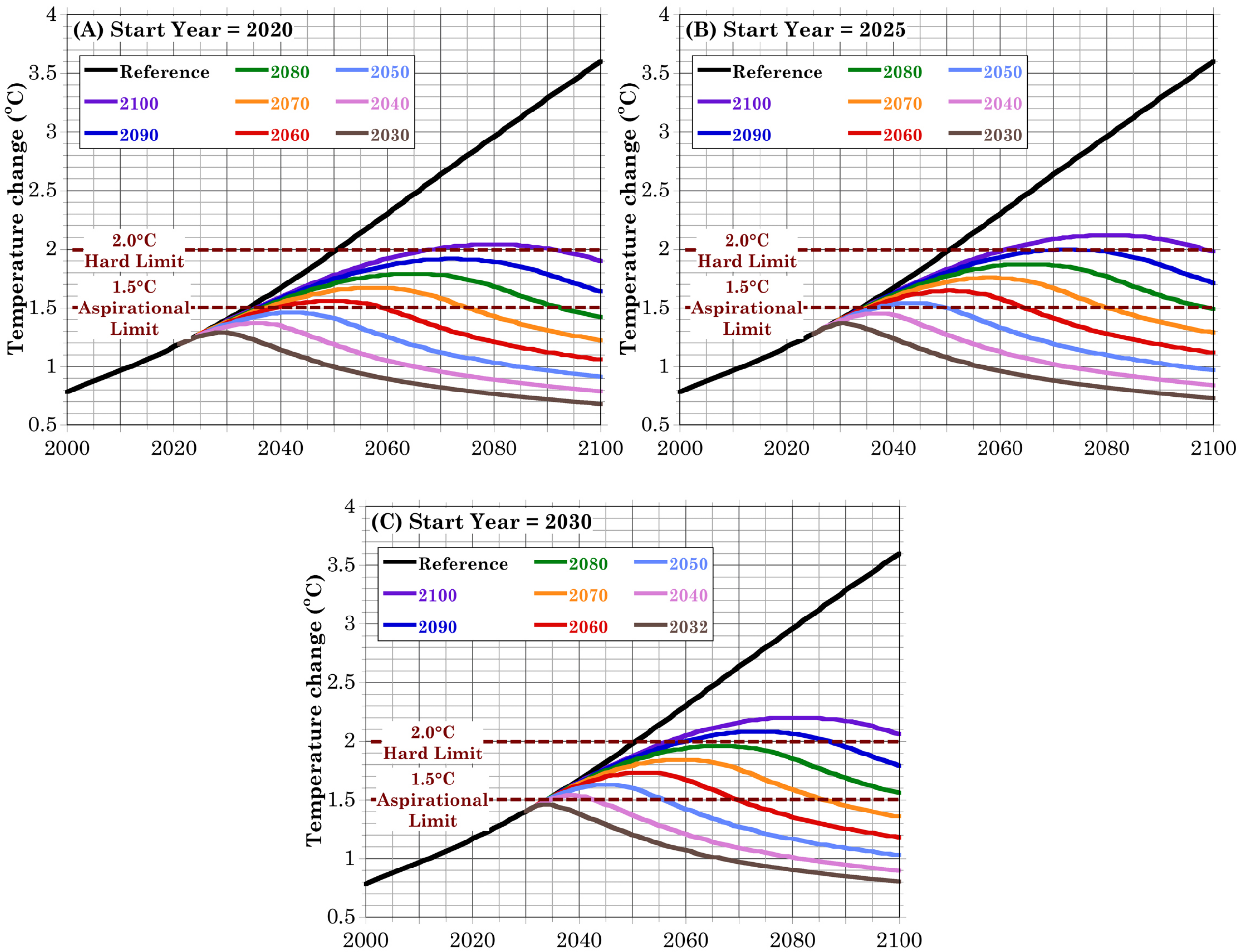

Figure 6. Change in global-mean near-surface air temperature relative to 1750 [degrees Celsius (˚C)] versus year in the 21st century for Start Years Y_S = 2020, 2025 and 2030, and End Years Y_E = 2100, 2090, 2080, 2070, 2060, 2050, 2040, 2030 (2032 for Y_S = 2030). The 2.0˚C Hard Limit and 1.5˚C Aspirational Limit of the 2015 Paris Climate Agreement are shown by the brown dashed lines.

The Global Warming for the Reference scenario increases monotonically across the 21st century, from 0.78˚C in 2000 to 3.6˚C in 2100. Global Warming exceeds the 1.5˚C Aspirational Limit and 2.0˚C Hard Limit of the Paris Climate Agreement in 2035 and 2051, respectively

The Global Warmings for the Reduced-emissions scenarios peak within the 21st century, with the peak occurring later and being larger the later the Start Year, Y_S, and for each Y_S, occurring sooner and being smaller the earlier the End Year, Y_E. The peak Global Warmings exceed the 1.5˚C Aspirational Limit for all Y_S, for $Y_E \geq 2060$ for $Y_S = 2020$, $Y_E \geq 2050$ for $Y_S = 2025$, and $Y_E \geq 2040$ for Y_S = 2030. The peak Global Warmings exceed the 2.0˚C Hard Limit for all Y_S, for Y_E = 2100 for Y_S = 2020 and 2025 and $Y_E \geq 2090$ for $Y_S = 2030$.

6. Analysis of the Global Warming Results

From the results of Figure 6 we determine the End Years Y_E for each Start Year Y_S = 2020, 2025 and 2030 required to keep Global Warming less than $\Delta T_{\max}$ =

2.0˚C, 1.9˚C, 1.8˚C, 1.7˚C, 1.6˚C and 1.5˚C.

Figure 7 shows the maximum temperature ΔT_{max} for each of the curves in Figure 6 versus End Year Y_E for Start Years Y_S = 2020, 2025 and 2030. We fit each of the three curves in Figure 7 with a quadratic polynomial,

$$\Delta T_{max} = AY_E^2 + BY_E + C, \quad (3)$$

with coefficients A, B and C presented in Table 1, together with the corresponding coefficients of determination, R^2.

6.1. Dependence of Emissions Phaseout Duration D on ΔT_{max}

We solved Equation (3) for Y_E for ΔT_{max} = 2.0˚C, 1.9˚C, 1.8˚C, 1.7˚C, 1.6˚C and 1.5˚C for Start Years Y_S = 2020, 2025 and 2030. The results are shown in Figure 8. We fit each of the three curves therein with a quadratic polynomial,

$$Y_E = A\Delta T_{max}^2 + B\Delta T_{max} + C, \quad (4)$$

with coefficients A, B and C presented in Table 2, together with the corresponding

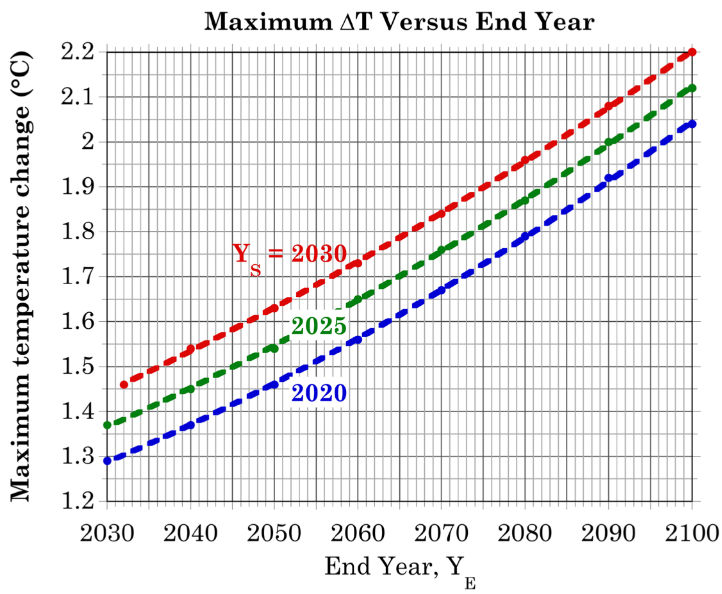

Figure 7. Maximum change in global-mean near-surface air temperature ΔT_{max} relative to 1750 [in degrees Celsius (˚C)] versus End Year Y_E for Start Years Y_S = 2020, 2025 and 2030. The quadratic curve fits are shown by the dashed lines.

Table 1. Coefficients of the quadratic fit of maximum global-mean near-surface air temperature change relative to 1750, $\Delta T_{max} = AY_E^2 + BY_E + C$, on End Year, Y_E, in Equation (3), for Start Years Y_S = 2020, 2025 and 2030 from Figure 7.

Coefficients	Start Year, Y_S		
	2020	2025	2030
A	4.1667e−5	3.5714e−5	2.9716e−5
B	−0.16125	−0.13667	−0.11189
C	156.92	131.62	106.13
R^2	0.99976	0.99972	0.99983

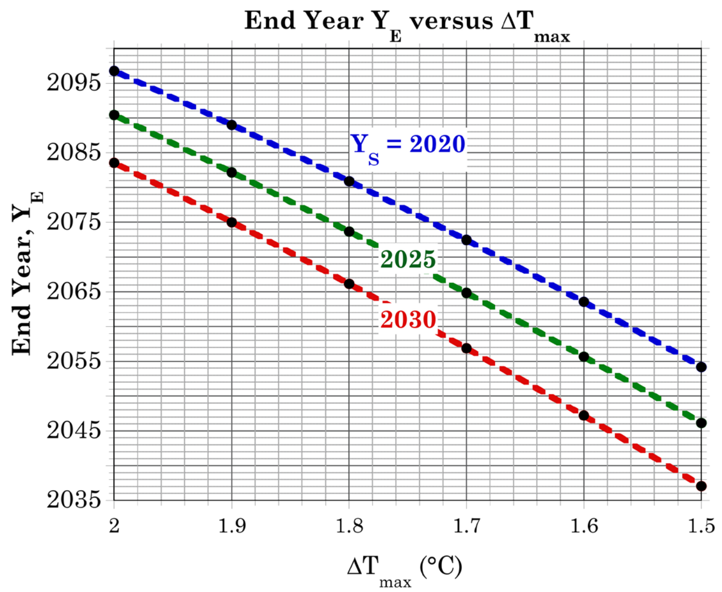

Figure 8. End Year Y_E versus ΔT_{max} for Start Years Y_S = 2020, 2025 and 2030. The quadratic curve fits are shown by the dashed lines.

Table 2. Coefficients of the quadratic fit of End Year, $Y_E = A\Delta T_{max}^2 + B\Delta T_{max} + C$, on ΔT_{max} in Equation (4) for Start Years Y_S = 2020, 2025 and 2030 from Figure 8.

Coefficients	Start Year, Y_S		
	2020	2025	2030
A	−19.928	−16.09	−20.105
B	154.78	144.82	163.27
C	1866.9	1865.1	1837.4
R^2	1	1	1

coefficients of determination, R^2.

We then calculated the duration of the phaseout of emissions as

$$D = Y_E - Y_S, \tag{5}$$

for ΔT_{max} = 2.0˚C, 1.9˚C, 1.8˚C, 1.7˚C, 1.6˚C and 1.5°C for Start Years Y_S = 2020, 2025 and 2030. The results are shown in Figure 9. We fit each of the three curves therein with a quadratic polynomial,

$$D = A\Delta T_{max}^2 + B\Delta T_{max} + C, \tag{6}$$

with coefficients A, B and C presented in Table 3, together with the corresponding coefficients of determination, R^2.

The Emissions Phaseout Period D decreases with decreasing ΔT_{max}, but more rapidly than linearly, this because the curvature A is negative, and increases in magnitude with increasing Start Year, Y_S. This means that D decreases with decreasing ΔT_{max} more the later the Start Year, Y_S. In particular, for Y_S = 2020, D decreases from 76 years for ΔT_{max} = 2.0˚C to 34 years for ΔT_{max} = 1.5˚C, while for Y_S = 2030, D decreases from 53 years for ΔT_{max} = 2.0˚C to 7 years for ΔT_{max} = 1.5˚C. This leads to:

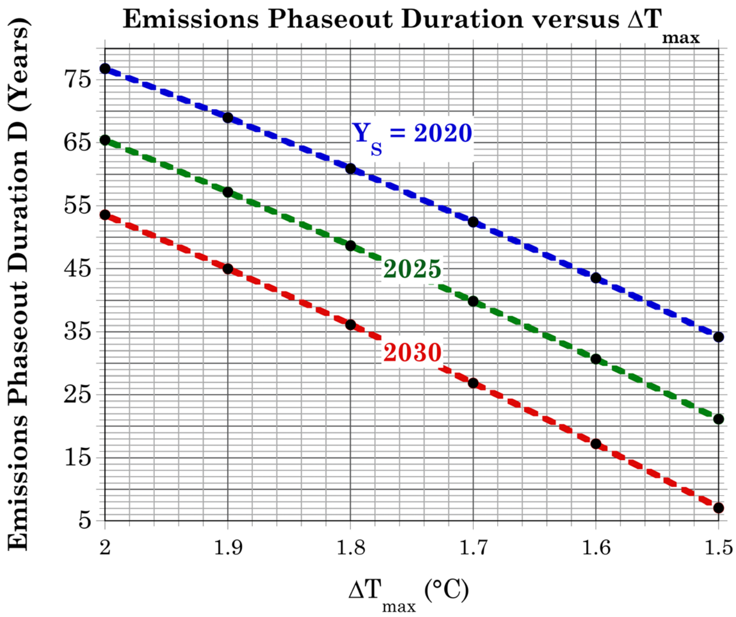

Figure 9. Emissions phaseout duration D versus ΔT_{max} for Start Years Y_S = 2020, 2025 and 2030. The quadratic curve fits are shown by the dashed lines.

Table 3. Coefficients of the quadratic fit of Emissions Phaseout Duration, $D = A\Delta T_{max}^2 + B\Delta T_{max} + C$, on ΔT_{max} in Equation (6) for Start Years Y_S = 2020, 2025 and 2030 from **Figure 9**.

Coefficients	Start Year, Y_S		
	2020	2025	2030
A	−19.928	−16.09	−20.105
B	154.78	144.82	163.27
C	−153.1	−159.86	−192.58
R^2	1	1	1

Finding 1: It will be increasingly difficult to phaseout emissions the smaller the temperature target, ΔT_{max}, and this difficulty will increase the longer humanity delays the initiation of emissions reductions.

6.2. Dependence of Emissions Phaseout Duration D on Start Year Y_S

Figure 10 presents the End Year, Y_E, versus Start Year, Y_S, for maximum global-mean near-surface air temperature relative to 1750 of ΔT_{max} = 2.0˚C, 1.9˚C, 1.8˚C, 1.7˚C, 1.6˚C and 1.5˚C. We fit each of the three curves therein with a quadratic polynomial,

$$Y_E = AY_S^2 + BY_S + C, \quad (7)$$

with coefficients A, B and C presented in **Table 4**, together with the corresponding coefficients of determination, R^2.

Figure 11 presents the Emissions Phaseout Duration D versus Start Year, Y_S, for maximum global-mean near-surface air temperature change relative to 1750

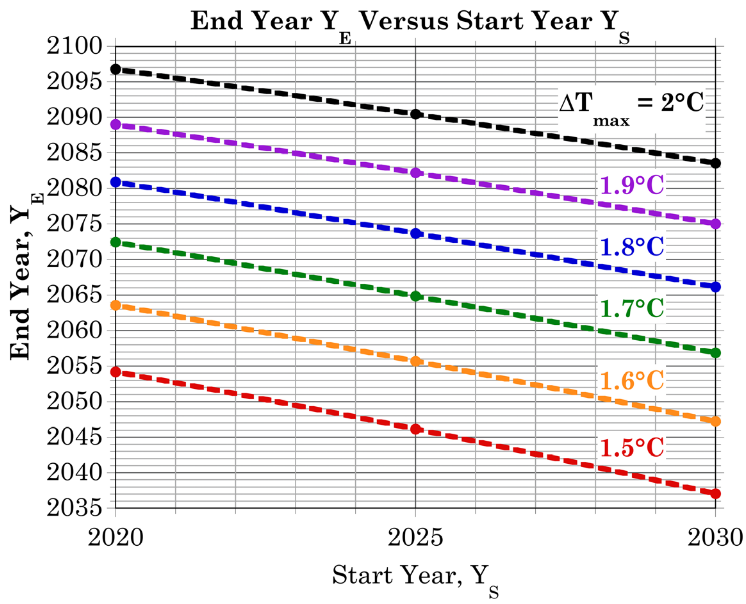

Figure 10. End Year, Y_E, versus Start Year, Y_S, for ΔT_{max} = 2.0˚C, 1.9˚C, 1.8˚C, 1.7˚C, 1.6˚C and 1.5˚C. The quadratic curve fits are shown by the dashed lines.

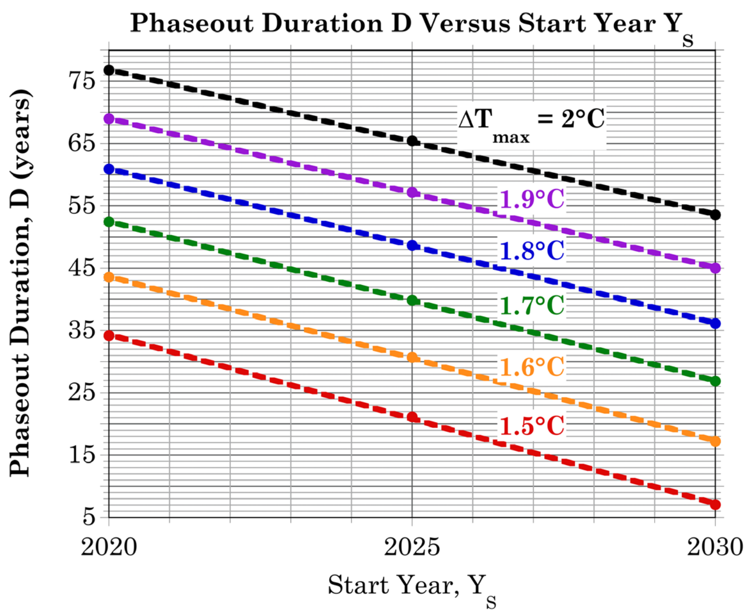

Figure 11. Emissions phaseout duration D versus Start Year, Y_S, for ΔT_{max} = 2.0˚C, 1.9˚C, 1.8˚C. 1.7˚C, 1.6˚C and 1.5˚C. The linear curve fits are shown by the dashed lines.

of ΔT_{max} = 2.0˚C, 1.9˚C, 1.8˚C. 1.7˚C, 1.6˚C and 1.5˚C. We fit each of the three curves therein with a straight line,

$$D = AY_S + B, \tag{8}$$

with coefficients A and B presented in Table 5, together with the corresponding coefficients of determination, R^2.

The emissions phaseout duration D decreases with increasing Start Year, Y_S,

Table 4. Coefficients of the quadratic fit of End Year on Start Year, $Y_E = AY_S^2 + BY_S + C$, for ΔT_{max} = 2.0˚C, 1.9˚C, 1.8˚C, 1.7˚C, 1.6˚C and 1.5˚C from Figure 10.

ΔT_{max} (˚C)	A	B	C
2.0	−0.010996	43.213	−40325
1.9	−0.0071972	27.751	−24600
1.8	−0.0058007	22.016	−18722
1.7	−0.0072069	27.632	−24337
1.6	−0.011797	46.142	−43007
1.5	−0.020801	82.528	−79778

Table 5. Coefficients of the linear fit of Emissions Phaseout Duration on Start Year, $D = AY_S + B$, for ΔT_{max} = 2.0˚C, 1.9˚C, 1.8˚C, 1.7˚C, 1.6˚C and 1.5˚C from Figure 11.

ΔT_{max}	Coefficients		
	$A = \Delta D/\Delta Y_S$	B	R^2
2.0	−2.321	4765.3	0.99981
1.9	−2.398	4913	0.99992
1.8	−2.477	5064.5	0.99995
1.7	−2.556	5215.6	0.99993
1.6	−2.635	5366.4	0.99983
1.5	−2.714	5516.7	0.99951

because the slope $A = \Delta D/\Delta Y_S$ is negative, and more so the larger ΔT_{max} is. This is shown in Figure 12 which presents $A = \Delta D/\Delta Y_S$ as a function of the allowed maximum Global Warming relative to 1750, ΔT_{max}. This leads to:

Finding 2: It will be increasingly difficult to phaseout emissions the longer humanity delays the initiation of emissions reductions, and this difficulty will increase the smaller the temperature target, ΔT_{max}.

Findings 1 and **2** are visually displayed and summarized in Figure 13 which presents the dependences of End Year, Y_E, and Emissions Phaseout Duration, D, on temperature target, for ΔT_{max} = 2.0˚C and 1.5˚C, and on Start Year, for Y_S = 2020, 2025 and 2030. It is clearly seen that Y_E and D decrease with increasing Start Year, Y_S, and decreasing Global Warming target, ΔT_{max}.

7. Conclusion

In our 10 antecedent Fair Plan papers, the emissions intensity, which multiplies the Reference emissions to generate Reduced emissions, decreased linearly from unity to zero for the Developed Countries, and more slowly initially for the Developing Countries, this such that the total cumulative trade-adjusted CO_2 emissions of the Developed and Developing Countries were equal. In our first paper, the Start Year, Y_S, of the emissions phaseout was chosen to be 2015 and End Year, Y_E, was chosen to be 2050. In our second and subsequent papers, we changed Y_S to 2020 and chose Y_E such that the Emissions Phaseout Duration, $D = Y_E - Y_S$, was as long as possible, this to minimize economic dislocation,

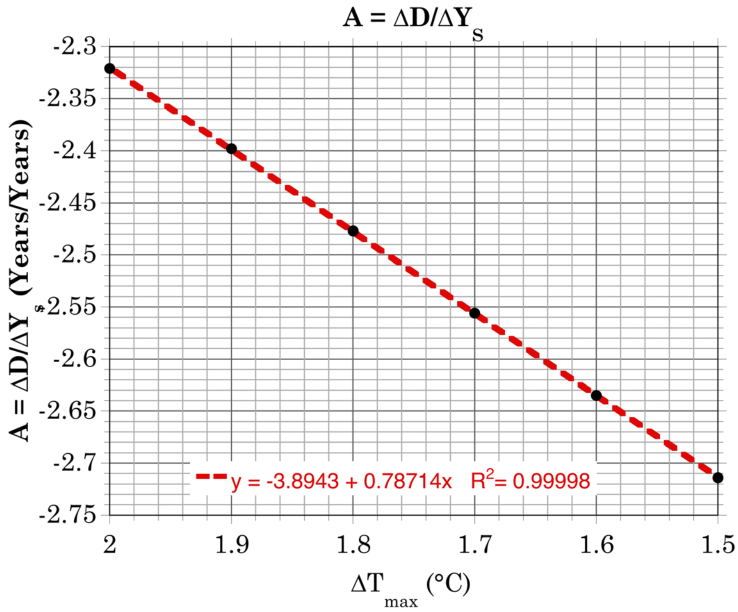

Figure 12. Change in Emissions Phaseout Duration per change in the Start Year from 2020, $\Delta D/\Delta Y_S$, as a function of the allowed maximum Global Warming relative to 1750, ΔT_{max}.

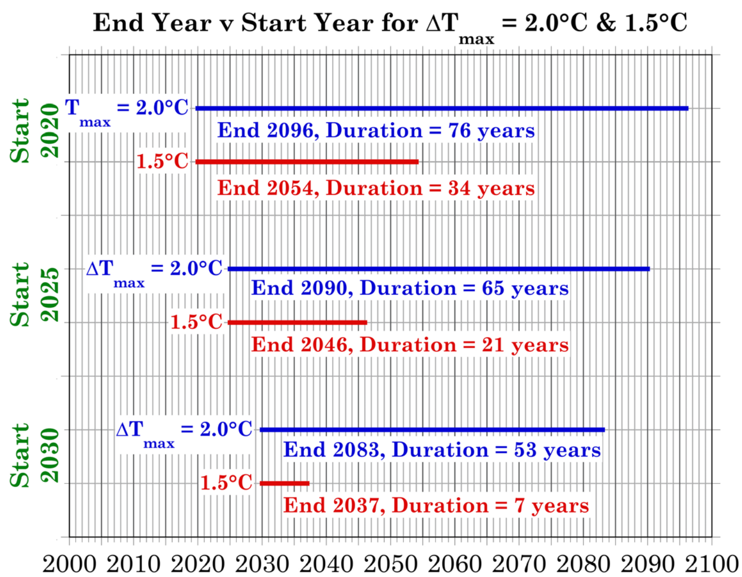

Figure 13. End year, Y_E, required to keep Global Warming below ΔT_{max} = 2.0˚C and 1.5˚C relative to 1750 for Start Years Y_s = 2020, 2025 and 2030.

while keeping the maximum Global Warming, ΔT_{max} = 2.0˚C, the "hard" target of the 2015 Paris Climate Agreement. Here we have used the linear emissions intensity for all countries, and have examined the change in D required to keep ΔT_{max} = 2.0˚C caused by a delay in initiating the emissions phaseout from Y_S = 2020 to Y_S = 2025 and Y_S = 2030. Because the 2015 Paris Climate Agreement has an "aspirational" Global Warming target of ΔT_{max} = 1.5˚C, we have also examined targets ΔT_{max} = 2.0˚C, 1.9˚C, 1.8˚C, 1.7˚C, 1.6˚C and 1.5˚C. We have done this to understand the effect of the likely delay in the initiation of emissions reduction due to the election of Donald Trump as President of the United States and his termination of the U.S.'s Clean Power Program, and the U.S.'s subsequent proposed withdrawal from the 2015 Paris Climate Agreement.

We have found, of course, that D decreases with decreasing ΔT_{max} and increasing Y_S.

For Y_S = 2020, D decreases from 76 years for ΔT_{max} = 2.0˚C to 34 years for ΔT_{max} = 1.5˚C. Could humanity zero the emission of greenhouse gases in 34 years? Perhaps, but it would require a heroic technological effort that would dwarf the U.S. Apollo program that took 12 men to the surface of the Moon and returned them safely to Earth.

For Y_S = 2030, D decreases from 53 years for ΔT_{max} = 2.0˚C to 7 years for ΔT_{max} = 1.5˚C. Thus, delaying the initiation of emissions reductions by 10 years, from 2020 to 2030, makes achieving ΔT_{max} = 2.0˚C more challenging, but likely doable, and makes achieving ΔT_{max} = 1.5˚C impossible.

Bottom Line: In order to maximize the likelihood of humanity's achieving ΔT_{max} = 2.0˚C, the initiation of the phaseout of humanity's emission of greenhouse gases should not be delayed past 2020.

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